



Arun Kumar Paul

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Practical Aspects of Emergency Anesthesia

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Step by Step[®]
**Practical Aspects
of
Emergency Anesthesia**

Arun Kumar Paul

BSc, MBBS, DA, MS (Anesthesia)

Ex-Professor, Department of Anesthesiology

Medical College and Hospitals

Kolkata, West Bengal

India



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Corporate Office

4838/24, Ansari Road, Daryaganj, New Delhi 110 002, India, Phone: +91-11-43574357

Fax: +91-11-43574314

Registered Office

B-3, EMCA House, 23/23B Ansari Road, Daryaganj, New Delhi 110 002, India

Phones: +91-11-23272143, +91-11-23272703, +91-11-23282021, +91-11-23245672

Rel: +91-11-32558559, Fax: +91-11-23276490, +91-11-23245683

e-mail: jaypee@jaypeebrothers.com, Website: www.jaypeebrothers.com

Branches

- ❑ 2/B, Akruiti Society, Jodhpur Gam Road Satellite
Ahmedabad 380 015, Phones: +91-79-26926233, Rel: +91-79-32988717
Fax: +91-79-26927094, e-mail: ahmedabad@jaypeebrother.com
- ❑ 202 Batavia Chambers, 8 Kumara Krupa Road, Kumara Park East
Bengaluru 560 001, Phones: +91-80-22285971, +91-80-22382956, Rel: +91-80-32714073
Fax: +91-80-22281761, e-mail: bangalore@jaypeebrothers.com
- ❑ 282 IIIrd Floor, Khaleel Shirazi Estate, Fountain Plaza, Pantheon Road
Chennai 600 008, Phones: +91-44-28193265, +91-44-28194897, Rel: +91-44-32972089
Fax: +91-44-28193231, e-mail: chennai@jaypeebrothers.com
- ❑ 4-2-1067/1-3, 1st Floor, Balaji Building, Ramkote Cross Road
Hyderabad 500 095, Phones: +91-40-66610020, +91-40-24758498, Rel: +91-40-32940929
Fax: +91-40-24758499, e-mail: hyderabad@jaypeebrother.com
- ❑ No. 41/3098, B & B1, Kuruvi Building, St. Vincent Road
Kochi 682 018, Kerala, Phones: +91-484-4036109, +91-484-2395739, +91-484-2395740
e-mail: kochi@jaypeebrothers.com
- ❑ 1-A Indian Mirror Street, Wellington Square
Kolkata 700 013, Phones: +91-33-22651926, +91-33-22276404, +91-33-22276415
Fax: +91-33-22656075, e-mail: kolkata@jaypeebrothers.com
- ❑ Lekhranj Market III, B-2, Sector-4, Faizabad Road, Indira Nagar
Lucknow 226 016, Phones: +91-522-3040553, +91-522-3040554
e-mail: lucknow@jaypeebrothers.com
- ❑ 106 Amit Industrial Estate, 61 Dr SS Rao Road, Near MGM Hospital, Parel
Mumbai 400 012, Phones: +91-22-24124863, +91-22-24104532, Rel: +91-22-32926896
Fax: +91-22-24160828, e-mail: mumbai@jaypeebrothers.com
- ❑ "KAMALPUSHPA" 38, Reshimbag, Opp. Mohota Science College, Umred Road
Nagpur 440 009 (MS), Phones: Rel: +91-712-3245220, Fax: +91-712-2704275
e-mail: nagpur@jaypeebrothers.com

North America Office

1745, Pheasant Run Drive, Maryland Heights (Missouri), MO 63043, USA Ph: 001-636-6279734

e-mail: jaypee@jaypeebrothers.com, anjulav@jaypeebrothers.com

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Step by Step® Practical Aspects of Emergency Anesthesia

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To

*My wife Kanyakumari
and
daughter, Sushmita
whose love, affection and support
has been invaluable*

PREFACE

Emergency anesthesia is itself a unique specialty in the discipline of anesthesiology substantially different in scope and practice than the other branches of the subject. Management of acute emergency cases seems to be the most challenging and vital task to be handled by the anesthetist. It demands some extra skill, updated knowledge and experience on the part of the anesthetist concerned with emergency anesthetic care. Practising anesthesia in emergency cases with critical turbulent conditions makes the anesthetist more perfect, well-confident and foolproof.

The present volume *Step by Step Practical Aspects of Emergency Anesthesia* aims to serve as a ready reference for all who provide anesthetic care for the patient with acute surgical conditions. The book covers the basics of emergency anesthesia in different branches particularly surgery, obstetrics, ophthalmology, ENT and trauma surgery.

It is concise, comprehensive, practical and direct. I strongly believe it will appeal to all anesthetists in general seeking a practical guide in the management of anesthesia in common surgical emergencies.

I am grateful to Shri Jitendar P Vij (Chairman and Managing Director), Mr Tarun Duneja (Director-Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd who actively inspired and cooperated in the entire project.

Arun Kumar Paul

CONTENTS

1. Emergency Anesthesia in General	1
2. Shock	11
3. Fluid, Electrolyte and Acid-base Disorders	23
4. Trauma	37
5. Burns	53
6. Anesthesia for Surgical Emergencies in Neonates, Infants and Children	63
7. Anesthesia for Obstetric Emergency	87
8. Anesthesia for Abdominal Emergency	109
9. Anesthesia for Emergency Neurosurgery	127
10. Emergency Anesthesia for Cardiothoracic Surgery	141
11. Emergency Anesthesia for Eye, Ear, Nose and Throat Surgery	161
12. Emergency Anesthesia and Common Pre-existing Medical Diseases	175
13. Miscellaneous	199
<i>Bibliography</i>	219
<i>Index</i>	221

CHAPTER 1

Emergency Anesthesia in General

2 Practical Aspects of Emergency Anesthesia

Management of emergency anesthesia poses one of the most challenging and important tasks needed for the anesthetist. It demands some extra skill, knowledge and experience to tackle the turbulent conditions in emergency situations.

These emergency cases may have uncertain diagnosis, uncontrolled concomitant co-existing medical illness, cardiovascular and metabolic derangements and no sufficient time to prepare for anesthesia and surgery.

Major problems in such cases include vomiting, regurgitation, aspiration of stomach contents, hypovolemia, hemorrhage and abnormal drug effects in presence of electrolyte and fluid disturbances and renal dysfunction.

PREANESTHETIC ASSESSMENT

Adequate preanesthetic evaluation of the general condition of the patient.

- Surgical diagnosis, surgical pathology, magnitude and extent of surgery, urgency of operation, time available for preanesthetic preparation.
- Any co-existing medical illness, past medical history
- Any drug therapy such as
 - Cardiac glycosides, digitalis. Suxamethonium may cause ventricular arrhythmia in digitalized cases, can cause bradycardia to halothane and neostigmine.
 - Antihypertensive drugs should be continued on the day of surgery. These patients may have labile cardiovascular status.
 - Beta adrenergic blocking drugs may have additive effects of myocardial depression of volatile anesthetics.
 - Diuretics can produce hypokalemia, hypovolemia, prolong the effects of muscle relaxants.
 - *Steroids*: May suffer from adrenocortical insufficiency. Steroid cover is needed in perioperative period.

- *Antibiotics*: Streptomycin, neomycin, kanamycin, polymixin, tetracyclines can potentiate nondepolarizing muscle relaxants.
- *Anticoagulants*: Patients with anticoagulant therapy should be controlled before surgery. Regional anesthesia is better avoided in such cases.
- MAO inhibitors like phenylzine, nialamide, pargyline, iproniazid, etc. may enhance the action of vasopressor drugs.
- Tricyclic antidepressants like imipramine, amitriptyline can enhance prominent anticholinergic effects producing tachycardia, arrhythmia and hypotension.
- Sedatives and tranquilizers can potentiate the effects of anesthetics, can cause prolonged recovery and develop hypotension.

PHYSICAL EXAMINATION

- Full physical examination should include cardiovascular system, respiratory system, alimentary system, musculoskeletal system and central nervous system.
- Assess cardiopulmonary status as far as practicable. Identify anemia, jaundice, cyanosis, edema, if any. Examine the lungs for any basal crepitations and the heart sounds to detect any arrhythmia, irregular rhythm.
- Evaluate the airway whether or not endotracheal intubation may pose difficulty. Examine the teeth, any denture, loose teeth, any protrusion of upper incisor, full opening of mouth, extension of cervical spine to anticipate safe intubation.
- Examine the skin condition particularly in cases of regional block.
- Examination note should always be documented.

INVESTIGATIONS

- Hemoglobin estimation, hematocrit, TC, DC, bleeding time, clotting time, prothrombin time.
- Urinalysis.
- Serum electrolytes, glucose, urea and creatinine.
- Chest X-ray in selected cases.
- ECG in all cases above the age of 40 years and where especially indicated.
- Blood gas analysis where special indications exist.

SPECIAL CONSIDERATIONS IN EMERGENCY CASES

Volemic Status

The extent of the intravascular volume is most important, otherwise hypovolemia will lead to circulatory collapse during anesthesia. Fluid may be lost during hemorrhage as in trauma or sequestered in peritonitis, intestinal obstruction, etc.

Assessment of blood loss is essential to restore the intravascular volume deficit. It is usually done with visual estimation, measuring the loss and clinical indices like pulse, blood pressure, urinary output, CVP and so on. Clinically, the extent of blood loss can be graded as minimal (10% blood volume loss), mild (20% loss), moderate (30% loss), and severe (over 40% blood volume loss).

- *10% loss:* Volume lost about 500 ml. Heart rate, BP, urinary output and CVP more or less normal.
- *20% loss:* Volume loss about 1000 ml. Heart rate 100-120/min, orthostatic hypotension, urinary output 20-30 ml/hr, CVP about—3 cm H₂O.
- *30% loss:* Volume loss about 1500 ml. Heart rate 120-140/min, systolic pressure below 100 mm Hg, urinary output 10-20 ml/hr, CVP—5 cm H₂O, patient is restless, cold and pale.

- *Over 40% loss:* Volume loss over 2000 ml. Heart rate above 140/min, systolic pressure below 80 mm Hg, anuria. Patient is comatose, pale, clammy, cyanosed, CVP—8 cm H₂O.

Note:

- Hypovolemia becomes clinically evident when blood volume is reduced by at least 1000 ml or 20% of blood volume.
- Classical shock syndrome occurs with a reduction of blood volume more than 30%.

Extracellular fluid volume deficit also needs attention though its assessment is difficult. Hemoconcentration occurs in an increased hemoglobin level and packed cell volume. In cases of severe dehydration, renal blood flow is reduced, renal clearance of urea is reduced and thus increases the level of blood urea. Low sodium content and high osmolality of urine are due to sodium and water conservation by the kidneys.

Main manifestations include weight loss, orthostatic hypotension, poor skin turgor, sunken eyes, tachycardia and reduced intraocular pressure.

It can be clinically graded as mild, moderate and severe as follows:

- *Mild:* About 6% body weight lost as water: Thirst, reduced skin elasticity, dry tongue, reduced sweating, low CVP, orthostatic hypotension, apathy, hemoconcentration.
- *Moderate:* About 8% body weight lost: Manifestations include hypotension, thready pulse, cold extremities.
- *Severe:* More than 10% body weight loss: Manifestations like coma, circulatory collapse are also added. It may even lead to death.

Following assessment of blood volume deficit or extracellular fluid volume deficit, restoration of the deficit is most important with adequate appropriate fluid. Blood transfusion may also be needed in presence of blood loss.

Full Stomach

- Emergency cases are always at risk of aspiration of gastric contents mostly due to full stomach. It may be necessary to induce anesthesia urgently before adequate preparation and starvation. Moreover, surgical condition may cause delayed gastric emptying.
- Vomiting is an active process and can occur during induction and emergence from anesthesia, but regurgitation is passive and can occur at any time, often silently causing aspiration even at deep planes of anesthesia.
- Gastric contents as little as 25 ml with a pH less than 2.5 can cause severe aspiration pneumonitis.

Predisposing Causes

- *Absent or abnormal peristalsis*: Peritonitis, metabolic ileus, hypokalemia, uremia, diabetic ketoacidosis, drugs like anticholinergics.
- *Obstructed peristalsis*: Intestinal obstruction, gastric cancer, pyloric stenosis.
- *Delayed gastric emptying*: Shock, fear, pain, anxiety, trauma, deep sedation, late pregnancy, recent intake of solids/fluids.
- *Miscellaneous*: Hiatus hernia, esophageal obstruction, pharyngeal pouch.

Preoperative measures to reduce the risk of regurgitation and aspiration:

- Delay surgery and allow gastric emptying.
- Preoperative fasting for 4 to 6 hours.
- Regional anesthesia may be appropriate.
- *Reduction of gastric volume*:
 - Large bore nasogastric tube to reduce stomach volume.
 - Metoclopramide facilitates gastric motility and increases lower esophageal sphincter tone.

- Increase of gastric pH:
 - Nonparticulate antacids: Sodium citrate
 - Histamine antagonists particularly H₂ receptor blockers: Ranitidine, Cimetidine
- *Use of antiemetic drugs:* Prochlorperazine, ondansetron.

PREANESTHETIC MEDICATION

- Premedication may not be needed in cases of emergency conditions.
- Sometimes only atropine sulphate is given IV at the time of induction of anesthesia to reduce secretions from the oropharynx and tracheobronchial tree.
- Proper explanation and reassurance are always helpful to relieve the anxiety and tension.
- Phenothiazine may be helpful in some cases for its antisialogogue, antiemetic, sedative and tranquillizing effects.
- Analgesics should be prescribed in selected cases only in presence of pain.

Preanesthetic Preparation

- Cardiovascular resuscitation
IV fluids, blood transfusion
- Nasogastric suction of gastric contents as far as practicable
- Neutralization of the pH of gastric contents: Sodium citrate
- Premedication, wherever needed.

Anesthetic Management

Induction

- *Crash induction (Rapid-sequence induction with cricoid pressure):*
 - Preoxygenation for 3 minutes with 100% oxygen (denitrogenation).

8 Practical Aspects of Emergency Anesthesia

- IV anesthetic agent: Thiopentone.
- Followed immediately by IV succinylcholine.
- Cricoid pressure to occlude the esophagus and press the larynx to improve visualization
- Place the endotracheal tube under direct laryngoscopy.
- Cricoid pressure should be maintained till verification of proper endotracheal intubation.
- *Awake intubation:* Blind nasal intubation may be tried in awake patient rendering the upper airway insensitive by local anesthetic.
- *Inhalational induction:*
 - Patient should be in left lateral, head down position.
 - Nitrous oxide, oxygen and halothane/isoflurane by facemask.
 - Followed by attempt to laryngoscopy and endotracheal intubation during spontaneous ventilation.

Maintenance of Anesthesia

- $\text{N}_2\text{O} + \text{O}_2 + \text{halothane/isoflurane}$; IPPV.
- $\text{N}_2\text{O} + \text{O}_2 + \text{intermittent doses of analgesic like pethidine and muscle relaxants like pancuronium/vecuronium/atracurium}$; IPPV.

Adequate fluid management is essential during operation. Blood transfusion may be necessary in cases of blood loss in excess of 15% blood volume in adults and 10% in children.

Monitoring of vital signs is essential during anesthesia and surgery.

Reversal and Emergence: Recovery from Anesthesia

- At the end of surgery, volatile anesthetics, if used should be discontinued a few minutes before the surgery finishes.
 - Direct pharyngoscopy and removal of secretions from pharynx.

- Extubation should be done gently when the patient is awake.
- Tonsillar position.
- If nondepolarizing muscle relaxants are used, adequate decurarization should be done with IV atropine and neostigmine. Ventilation is maintained manually so that spontaneous respiratory activity returns.
 - Extubation should be done when the trachea regains adequate protective reflexes. Patient should regain consciousness and fully awake.
 - Patient should be kept in lateral position.
 - Adequacy of neuromuscular function should always be guaranteed before sending the patient to the recovery room.

Postoperative Management

- Oxygen therapy.
- IPPV, if required.
- Monitoring of vital signs is essential.
- Fluid therapy should be meticulous.
- Nasogastric suction and measurable losses should always be replaced.
- Blood transfusion may be needed with proper assessment of blood loss.
- Postoperative analgesics may be needed.
- Postoperative ventilatory assistance may be needed in certain conditions such as:
 - Shock.
 - Severe sepsis, peritonitis
 - Upper abdominal/thoracic surgery
 - Aspiration pneumonitis
 - Morbid obesity
 - Low general condition
 - Severe ischemic heart disease
 - Prolonged massive trauma/surgery.

REGIONAL ANESTHESIA

The use of regional anesthesia is mostly safe and suitable for emergency surgery. Nerve blocks, spinal and epidural anesthesia are mostly satisfactory provided adequacy of extracellular fluid volume or vascular volume is maintained. These techniques satisfy the surgical needs such as immobility of the operative part, analgesia and profound muscular relaxation. Moreover, these have little effect on physiological response to injury (surgery) and continued analgesia in the postoperative period. Catheter technique of epidural analgesia can provide prolonged period of anesthesia, whenever needed.

CHAPTER 2

Shock

INTRODUCTION

Shock may be defined as a state of generalized failure of circulation to meet systemic demands for oxygen. Inadequate tissue perfusion causes impaired cellular metabolism and if not treated progresses to multiple organ failure.

Manifestations

- Decline in mental state, anxiety, agitation, apathy, coma
- Relative hypotension
- Weak or absent peripheral pulses
- Tachycardia, tachypnea
- Poor distal perfusion of the extremities
- Pallor, cold skin, diaphoresis
- Metabolic acidosis, (lactic acidosis)
- Oliguria, tubular necrosis.

Classification

- Hypovolemic shock
- Cardiogenic shock
- Septic shock
- Anaphylactic shock

CAUSES OF SHOCK

Cardiogenic

- *Primary:* Myocardial infarction, gross arrhythmia, myocardial failure.
- *Secondary:* Pericardial tamponade, vena caval obstruction, pulmonary embolism, tension pneumothorax.

Circulation Failure

- *Hypovolemic:* Severe hemorrhage, blood loss, plasma loss (burns), ECF loss (dehydration)
- *Normovolemic:* Sepsis, bacteremia, septicemia, neurogenic shock, anaphylaxis, spinal cord insult.

Assessment

- Monitoring of vital signs: Pulse, respiration, blood pressure, body temperature
- Electrocardiogram
- Complete blood count, hematocrit
- Serum electrolytes, creatinine
- Arterial blood gas analysis
- Arterial blood lactate estimation
- Central venous pressure
- Pulmonary artery occlusive pressure
- Urine analysis, urine output.

PATHOPHYSIOLOGY OF HYPOVOLEMIC SHOCK

- In the initial stage, a reduction in circulating volume causes an increase in sympathetic stimulation and thereby vasoconstriction. It leads shunting of blood from skin, viscera and muscle to preserve the coronary and cerebral circulation. Constriction of both pre and post-capillary sphincters occurs. This reduces the hydrostatic pressure in the capillary bed and thereby causes the osmotic pressure to draw the fluid back into the vascular compartment from the interstitial space. This hemodilution occurs to increase the contracted blood volume.
 - Hemotocrit can serve to assess the balance between loss of blood or plasma and gain of extracellular fluid. Hematocrit falls for several hours following untreated hemorrhage. But it will rise in case of major plasma loss as in burns.
- Myocardial depression can produce in fall of cardiac output and can cause reflex vasoconstriction.
- Decreased capillary perfusion due to peripheral vasoconstriction and impaired oxygen transport always

produce anaerobic metabolism with accumulation of carbon dioxide and lactic acid in interstitial space. Thus metabolic acidosis is almost inevitable in shock.

- Acidosis produces dilation of precapillary sphincters but postcapillary sphincters still remain constricted. Thus blood enters the capillary bed but cannot exit. It causes stagnation, sludging and aggregation and increase in capillary hydrostatic pressure. There is escape of fluid into interstitial space, and loss of integrity of capillary wall. All these cause a drastic fall of effective circulating blood volume and the stage of irreversible shock ensues. With progressive reduced perfusion, anaerobic metabolism continues with production of increased lactic acid.
- Hypovolemia is also significantly contributed by the loss into pathological spaces as, for example loss into the gut lumen, through fistula, etc.
- Acute respiratory failure (shock lung, ARDS) can occur following hemorrhagic shock. Damage at the alveolar capillary membrane causes leakage of protein rich fluid from the intravascular space into the alveolar space resulting in pulmonary edema, atelectasis and hemorrhagic necrosis. Progressive hypoxia, decreased pulmonary compliance, a fall in resting lung volume and functional residual capacity are prominent lung dysfunctions in ARDS.
- **Note:** Acute blood loss of about 10% blood volume can be reasonably tolerated in average healthy subject and adequate compensation is expected. But blood loss excess of 20% blood volume needs adequate replacement therapy. Whole blood transfusion or component therapy may also be needed. Colloid or crystalloid fluids are also used as volume expansion therapy. Care should be taken to maintain urinary output at near normal levels. In

presence of alveolar capillary damage extra caution is needed not to further aggravate pulmonary edema. Blood loss over 40% blood volume may initiate irreversible shock, if not treated adequately in right time.

Metabolic Effects of Shock

- Oxygen consumption decreased.
- Body temperature falls.
- Blood glucose level increased initially, but later falls.
- Blood lactate and pyruvate increase.
- Metabolic acidosis.
- Hepatic and renal function impaired.
- Initial increase of hypothalamic-pituitary-adrenal activity.

Treatment of Hypovolemic Shock

Rapid restoration of adequate tissue perfusion is the goal of therapy.

Fluid and Volume Replacement

Blood:

Hemorrhagic shock ideally needs blood transfusion. Plasma or its substitutes can be used, if delay occurs to get the whole blood in time. Whole blood transfusion has its own hazards and one should be extremely cautious at the time of blood transfusion. Fresh blood provides maximum live cells and this is always better to increase the oxygen transport.

Plasma

Plasma protein fraction

Fresh frozen plasma:

Plasma preparations can be given without blood grouping. It provides negligible oxygen carrying capacity. It can disperse from extravascular to intravascular fluid compartment relatively rapidly.

Plasma substitutes:

An ideal plasma substitute should have osmotic pressure as that of plasma. It should remain in circulation for considerable time to effect its function. It should be disposed by metabolic degradation and excretion. It should not adversely affect the body.

- *Dextrans:* These are long chain polysaccharides available in different molecular weights. Dextran 40, dextran 110 and dextran 70. Dextran 70 (molecular weight 70000) are mostly popular as these are mostly free from serious side effects and can remain reasonable time period in the circulation.
- *Gelatins:* These are obtained by the hydrolysis of crude collagen.
- *Hydroxyethyl starches:* It should be noted that these substitutes do not provide oxygen carrying capacity and contain no clotting factors. They can interfere with cross-matching of blood. Severe anaphylactoid reaction can occur in some cases.

While administering plasma substitutes, hemoglobin level should be kept at about 9 gm% and hematocrit should be about 30% for efficient tissue oxygenation.

Electrolyte solutions:

- Crystalloids are not so efficient to expand the volume due to its rapid transfer to the extracellular space. But these may be indicated as replacement for the loss of extracellular fluid into the cell.
- Normal saline, Ringer's lactate, Hartmann solution, glucose saline, etc. are being used satisfactorily particularly in the initial stage of shock unless there is evidence of pulmonary congestion.
- Estimation of blood loss is most important for fluid and volume replacement. The amount of blood needed should

be adequate to restore basic measurements to normal. CVP should be maintained 5 to 10 cm H₂O, pulse rate will fall, blood pressure will rise and skin temperature should return to normal, urinary output should be greater than 0.5 ml/kg/hour.

Drug Therapy

- Various catecholamines are being used in treatment of shock. These include noradrenaline, dopamine, isoprenaline and dobutamine, etc.
- Inotropic drugs, vasopressors are needed to augment cardiac output and perfusion of vital organs. Care should be taken to use these drugs only after an adequate circulating volume is established.
- Sodium bicarbonate is indicated for correction of severe metabolic acidosis. The dose should be guided by arterial blood gas analysis and the arterial pH should be maintained near normal.
- Use of steroids in shock is not well defined. It may have some value in cases of bacteremic shock. However, high dose steroids can enhance microcirculation by causing vasodilation, increasing cardiac output and protecting the integrity of small vessels.

Other Therapeutic Measures

- *Oxygenation:* Mechanical ventilation may be needed to maintain PaO₂ more than 60 mm Hg.
- Posture in shock. Elevation of legs 15 to 20° helps venous return to heart and prevents pooling in the dependent limbs. Head down tilt is not much recommended.
- Analgesic drugs may be indicated in presence of pain. But extra care is needed as most of them can cause respiratory depression and fall in blood pressure.

CARDIOGENIC SHOCK

It is a severe degree of pump failure. It is mostly due to myocardial infarction indicating a massive loss of functioning myocardium. The other causes include:

- Dysrhythmias
- Mechanical complications such as acquired septal defect, papillary muscle rupture, ventricular aneurysm.
- Other cardiopulmonary causes cardiac tamponade, pneumothorax, pulmonary embolism, dissecting aneurysm, etc.

Pathophysiology

- Central venous pressure (right atrial pressure) is increased.
- *Left ventricular function*: Reduction in stroke volume, increase in end diastolic pressure, increased mean left atrial pressure, pulmonary congestion.
- Coronary artery perfusion diminishes as cardiac output falls.

Diagnosis

- *Hypotension*: Systolic blood pressure less than 80 mm Hg; mean blood pressure less than 60 mm Hg.
- *Oliguria*: Urine volume less than 500 ml/24 hours.
- Elevated filling pressure.

Treatment

General Measures

- Relief of pain is most vital.
- Oxygenation.
- Correction of metabolic acidosis. Sodium bicarbonate should be given according to arterial blood gas analysis.
- Correction of dysrhythmias, if any.
- Fluid therapy, if needed should be cautious and guided by CVP.

Drug Therapy

- Isoprenaline.
- Salbutamol.
- Digoxin.
- In cases of dysrhythmia; drug therapy, cardioversion, pacemaker.

Surgery in correctable lesions, aortic balloon pumping and external counterpulsation.

BACTEREMIC (SEPTIC) SHOCK

The incidence is comparatively high in neonates, in the aged and debilitated patients. Predisposing factors include urinary tract infection, peritonitis, renal failure, diabetes, burns, skin sepsis, septic abortion, virulent pneumonia, surgery on colon, cytotoxic therapy and so on. Gram-negative bacillary bacteremia is mostly severe and its mortality rate is high.

Clinical Stages

- *Initially hyperdynamic phase (warm shock):* Cardiac output is elevated, peripheral vascular resistance is reduced. Patient is warm, sweating and vasodilated.
- *Progressing hypodynamic phase (cold shock):* Normal or increased peripheral vascular resistance. Patient is cool, skin vasoconstricted, decreased cardiac output.

Diagnosis

- Careful physical examination
- Chest X-ray
- Blood examination
- Urine analysis
- Examination of infected body fluids
- Blood culture.

Treatment

- Maintenance of regional perfusion by adequate fluid and volume replacement. Crystalloid fluid therapy. CVP monitoring is essential.
- Vasopressor drugs.
- Adequate oxygenation, ventilation. IPPV.
- Correction of acid-base changes and electrolyte changes.
- Antibiotics as dictated by blood culture.
- High doses of steroids in early stage may be helpful.
- Disseminated intravascular coagulation can occur. Early diagnosis and necessary treatment are important. Fresh frozen plasma and heparin may be needed.

ANAPHYLACTIC SHOCK

- Anaphylaxis is an acute hypersensitivity manifestation due to exposure of antigen in a sensitized person usually mediated by immunoglobulin E (IgE) antibodies.
- Anaphylactoid reactions are mediated by direct release of chemical mediators triggered by nonantigenic substances. It can occur with the first exposure to an antigen.
- These reactions may occur after exposure of substances like pollen, drugs, insect-sting, vaccines, antibiotics, protamine, aminoester local anesthetics, blood and blood products, iodinated contrast material, food products, etc.

Clinical Features

Apprehension, skin rash, pruritus, flush, angioedema, hypotension, cardiovascular collapse, arrhythmia, pulmonary edema, bronchospasm, hypoxemia, stridor, laryngeal edema, laryngospasm, dyspnea.

Management

- Adrenaline IV
- Antihistaminics
- Maintain a patent airway, support oxygenation and ventilation
- Aminophylline to treat bronchospasm
- Fluid therapy for volume expansion
- Vasopressors to treat hypotension
- Hydrocortisone
- Careful monitoring of vital signs is essential
- Arterial line should be well-established. CVP or PA catheter and urinary catheter are also needed.

Note: The most common cause of shock in patient with acute trauma is massive blood loss. These actively bleeding patients may need urgent surgical intervention to avoid the potential end organ dysfunction. Early resuscitation and treatment of shock and skillful anesthetic management are most vital.

CHAPTER 3

Fluid, Electrolyte and Acid-base Disorders

DEHYDRATION

Combined sodium and water deficiency

Causes

- Severe vomiting, diarrhea, intestinal obstruction, pyloric stenosis, cholera, etc.
- Excessive sweating.
- Chronic heart failure, salt losing nephritis, Addison's disease, diabetes.
- Severe hemorrhage.
- Severe plasma loss (burns).

Clinical and Biochemical Manifestations

- Sunken eyes, skin wrinkled, dry tongue.
- Tachycardia, blood pressure low.
- Veins poorly filled.
- Oliguria.
- Plasma volume reduced.
- Raised level of proteins, packed cell volume and hemoglobin.
- Blood viscosity increases.
- Plasma sodium level diminishes.
- Rising blood urea indicates renal failure.
- Circulatory failure.

Treatment

- Identify the cause of volume loss and treat it.
- Administer saline solutions.
- Blood or colloids solution may also be indicated.

HYPERKALEMIA

It is mostly due to renal insufficiency to excrete potassium.

Causes

- Acute renal failure with anuria.
- Terminal uremia of chronic renal failure.
- Addison's disease, hypoaldosteronism.
- Rapid infusion of potassium salts in cases of hypokalemia.
- After massive blood transfusion, hemolysis.
- Drugs those impair potassium excretion: Triamterene, spironolactone, nonsteroidal anti-inflammatory drugs.
- Drugs those inhibit renin angiotensin aldosterone system, β blockers, ACE inhibitors.

Clinical Manifestations

- Confusion, apathy, paresthesia.
- Severe muscular weakness.
- Cardiac dysfunction, Peaked T wave, loss of P waves, widening of QRS complex in ECG.
- Ventricular fibrillation.
- Serum potassium above 5.5 mEq/lit.

Note: A pre-existing hyperkalemia may be exacerbated in some conditions:

- Following suxamethonium.
- Hypoxia.
- Adrenaline either exogenous or endogenous.
- Hypercapnia.

Treatment

- Avoid potassium containing drugs or solutions.
- Correction of hypoxia.
- Oxygenation and proper ventilation.
- Calcium gluconate, IV bicarbonate, glucose and insulin.
- Use of ion-exchange resins.
- Peritoneal dialysis, Hemodialysis.
- Dietary potassium restriction and sodium polystyrene sulfonate or loop diuretic to lower potassium subacutely.
- Anti digitalis Tc antibodies in patients with digitalis.

Anesthetic Considerations

- Attempt to lower the plasma potassium before elective surgery.
- Adequate monitoring of the adverse effects of hyperkalemia. ECG and plasma potassium estimation should be done.
- Avoid hypoventilation.
- Avoid suxamethonium.
- Avoid IV fluids containing potassium.

HYPOKALEMIA

Plasma potassium concentration is less than 3.5 mEq/lit. Loss of potassium usually takes place either from gastrointestinal tract or from urine.

Causes

- Diuretic therapy, diuresis.
- Excessive losses from GI tract, vomiting, diarrhea.
- Peritoneal dialysis.
- Diabetic ketosis.
- Cushing's syndrome, hyperthyroidism.
- Cirrhosis liver.
- Congestive cardiac failure.
- Excessive cortisol.
- Altered distribution of potassium between intra and extracellular fluid.
 - Alkalosis.
 - Glucose and insulin.
 - Hypercalcemia.
 - Hypomagnesemia.
 - Familial periodic paralysis.
- Magnesium depletion.

Clinical Manifestations

- Lethargy, apathy, anorexia, confusion, amnesia, nausea.
- Skeletal muscle weakness, asthenia.
- Polyuria.
- Metabolic alkalosis.
- Hypotension.
- Myocardial weakness, conduction defect.
- Serum potassium < 3.5 mEq/lit.
- ECG changes: Flattened T waves with ST segment depression.

Treatment

- Oral or IV potassium supplementation.
- Correction of excessive hyperventilation.
- Identify and treat the underlying cause.

Anesthetic Considerations

- Avoid glucose loads.
- Avoid hyperventilation.
- Nondepolarizing muscle relaxants may have prolonged effect.
- Avoid drugs that cause low potassium.
- ECG and plasma potassium estimation should also be monitored.

HYPERNATREMIA

High serum sodium levels (more than 145 mEq/lit) may occur in

- Drug administration, mineralocorticoid excess.
- Excessive IV infusion of sodium containing fluids, sodium bicarbonate.
- Dehydration (diarrhea, sensible losses, osmotic diuresis).

Clinical manifestations depend on the ECF volume status, circulatory overload or volume contraction.

- Severe thirst, oliguria.
- Altered mental status, delirium, muscle irritability, convulsion, coma.
- In presence of hypovolemia, tachycardia, hypotension, decreased skin turgor.
- Serum sodium level more than 145 mEq/lit.
- Serum osmolality more than 300 mEq/lit.
- Peripheral edema and hypertension in cases of expanded intravascular fluid volume.

Treatment

- *When ECF volume is excess:* Excess total sodium needs removal either by diuresis or dialysis in cases of renal failure. Water replacement should be done by administering 5% dextrose solution.
- *When ECF volume is depleted:* In presence of circulatory impairment, salt and water deficit needs correction with isotonic saline. Following hemodynamic stability, the remaining fluid deficit should be corrected with 5% dextrose solution or hypotonic saline.

HYPONATREMIA

A reduced serum sodium level (<135 mEq/lit).

Causes

- *Associated with hypovolemia:* Vomiting, diarrhea, third space sequestration. adrenal insufficiency, osmotic diuresis, thiazides, hypoaldosteronism, salt-losing nephropathy.
- *Associated with hypervolemia:* Renal failure, congestive heart failure, cirrhosis liver, nephrotic syndrome, pregnancy.

- *Associated with normovolemia:* Syndrome of inappropriate ADH(SIADH), hypothyroidism. Water intoxication due to excessive administration of water or hypotonic IV solutions particularly in presence of renal insufficiency. Following transurethral prostatectomy, cystoscopic surgery, etc.
- Hypertonic or isotonic hyponatremia: Hyperglycemia, IV mannitol infusion.
- Pseudohyponatremia: Severe hyperlipidemia, hyperproteinemia.

Manifestations

- Nausea, vomiting, anorexia.
- Lethargy, weakness.
- Confusion, irritability, generalized convulsion.
- Coma.
- Respiratory arrest, death.
- Serum sodium less than 130 mEq/lit. osmolality less than 280 mEq/lit.

Management

- Diagnose the causative factor and treat accordingly.
- Corticosteroids in cases of adrenal insufficiency.
- Gradual correction of serum sodium is recommended, not more than 0.5 mEq/lit per hour unless serious CNS signs are present.
- If hypovolemic: IV infusion of normal saline.
- If hypervolemic: Water restriction, loop diuretics and cautious replacement of urine output by normal saline.
- Hypertonic saline should not be used unless patient is markedly symptomatic or with a low sodium and low osmolality.

Note

- Sodium content of common infusion fluids in mmol/lit.:
Citrated plasma: 150
Normal saline (0.9%): 150
Hartmann solution: 131
Sodium bicarbonate 1.4%: 167
Sodium lactate M/6: 167
- Sodium deficit (mmol) can be calculated as $(140 - \text{plasma sodium}) \times \text{body weight in kg} \times 0.6$

HYPERCALCEMIA

Calcium is most vital for nerve and skeletal muscle excitability. Nonionized calcium is physiologically active. It is bound to albumin. Normal serum level ranges from 4.5 to 5.7 mEq/lit, total 8.5 to 10.5 mg%; ionized 4 to 5 mg%. In hypercalcemia, serum calcium is more than 5.5 mEq/lit.

Causes

- Primary hyperparathyroidism.
- Neoplastic diseases with metastasis in bones.
- Vitamin D intoxication.
- Sarcoidosis.
- Paget's disease of bone.
- Hyperthyroidism.
- Milk alkali syndrome.
- Adrenal insufficiency.
- Loop diuretics.

Manifestations

- Thirst, dehydration.
- Anorexia, nausea, vomiting, abdominal pain.
- Constipation, polyuria.
- Mild hypertension.

- Altered mental status, psychosis, stupor, coma.
- Renal dysfunction, azotemia.
- Serum calcium raised.
- ECG: Shortened QT interval due to short ST segment and ventricular extrasystoles.

Management

- The etiological factor should be determined and treated accordingly.
- Rehydration, volume expansion, diuretics.
- Glucocorticoids, calcitonin, bisphosphonates may be included in certain cases.
- Dialysis
- Resection of parathyroid adenoma, if present.
- Restriction of intake of calcium.
- Maintain adequate urine output.

HYPOCALCEMIA

Serum calcium concentration is below 4.5 mEq/lit.

Causes

- Vitamin D deficiency, osteomalacia.
- Hypoparathyroidism.
- Chronic renal failure.
- Hypoalbuminemia.
- Hypophosphatemia, hypomagnesemia.
- Loop diuretics.
- Citrate intoxication in cases of massive blood transfusion.

Manifestations

- Muscle cramps, laryngospasm.
- Tetany, convulsion.
- Numbness, circumoral paraesthesia.
- Hypotension.

- Diplopia, papilledema.
- ECG changes: Prolonged QT interval, ventricular arrhythmias.
- Serum calcium low.

Management

- Identify the cause and treat accordingly.
- IV calcium gluconate to control tetany, convulsion.
- Magnesium replacement.
- Oral calcium and vitamin D supplementation.

Anesthetic Considerations

- Alkalosis should be avoided.
- Intraoperative hypotension, cardiac depression can occur.
- Severe muscle spasm, laryngospasm, convulsion can occur.

METABOLIC ACIDOSIS

It results from the accumulation of nonvolatile acid or from loss of alkali. There is a fall in both the pH of blood and bicarbonate level of the plasma.

Causes

- Inadequate tissue oxygenation (lactic acidosis), profound shock
- Renal failure, uremia.
- Ketoacidosis, starvation.
- Hepatic failure.
- Increased skeletal muscle activity.
- *Drug intoxication:* Methanol, salicylate, ethylene glycol, paraldehyde, cyanide, carbon monoxide.
- Diarrhea, renal tubular acidosis.

Clinical and Biochemical Effects

- Air hunger, deep sighing rapid respiration.
- Dyspnea, respiratory fatigue.
- Tachycardia, tachypnea.
- Hypotension, shock.
- Acetone breath in diabetic ketoacidosis.
- Arterial pH < 7.5; serum bicarbonate level decreased, ketonuria.

Management

- Reverse the underlying etiology, whenever possible.
- Correction of volume and electrolyte status.
- Bicarbonate therapy is much indicated in ethylene glycol or methanol toxicity and renal tubular acidosis.
- Hemodialysis, mechanical ventilation, if necessary.
- Sodium bicarbonate causes endogenous CO₂ production. It needs increase in alveolar ventilation to prevent hypercarbia, otherwise it will worsen the existing acidosis.

METABOLIC ALKALOSIS

It is characterized by loss of nonvolatile acids from the extracellular fluid. It causes a rise both in pH of blood and the bicarbonate level of plasma.

Causes

- Vomitting, nasogastric suction, pyloric stenosis.
- Use of diuretics, volume contraction.
- Excess mineralocorticoid, Cushing's syndrome.
- Profound potassium depletion.
- Excess alkali administration.

Clinical and Biochemical Manifestations

- Muscular weakness, malaise, lethargy.
- Hyporeflexia, tetany, ileus.
- Hypoventilation.
- Arterial pH > 7.5.
PaCO₂ upto 45 mm Hg.
Serum bicarbonate level > 30 mEq/lit.
Potassium and chloride usually low.

Management

- The underlying causes should be detected and corrected.
- Correction of ECF volume and electrolyte status.
- Supplement potassium chloride.
- Rarely in severe metabolic alkalosis, cautious IV administration of HCl may be needed. Alternatively, NH₄Cl or arginine HCl may help.

RESPIRATORY ACIDOSIS

It is due to insufficient pulmonary removal of CO₂ (increased PCO₂) causing an increase of H₂CO₃.

Causes

- *Alveolar hypoventilation:* Drugs causing CNS depression.
- *Neuromuscular disorders:* Myopathy, Guillain-Barre syndrome, myasthenia gravis.
- *Pulmonary diseases:* Asthma, COPD, pneumothorax.
- Myxoedema.

Clinical and Biochemical Manifestations

- Alveolar hypoventilation, respiratory depression.
- Confusion, altered mental status, somnolence.
- Cyanosis.
- Arterial PCO₂ increased.
Arterial pH decreased.

Management

- Treat the underlying cause and correct it.
- Adequate ventilation, oxygenation. IPPV.
- Rapid lowering of chronically increased arterial PCO_2 can decrease body stores of CO_2 more rapidly than the renal excretion of HCO_3 leading to metabolic alkalosis.

RESPIRATORY ALKALOSIS

It is usually caused by increased pulmonary excretion of carbon dioxide.

Causes

- Anxiety.
- Sepsis.
- Salicylate overdose.
- Hypoxemia.
- *Lung diseases*: Pulmonary edema, pulmonary embolism, pneumonia.
- Thyrotoxicosis.
- Pregnancy.
- Liver diseases.
- Excessive ventilation from mechanical ventilation.
- Central nervous system injury.
- Decreased barometric pressure.
- Iatrogenic.

Clinical and Biochemical Manifestations

- Light headedness.
- Paresthesia, numbness, tingling.
- Tetany, carpopedal spasm.
- Cardiac arrhythmias.
- Arterial blood gas analysis.
Increased pH (> 7.45).
Decreased PCO_2 (< 30 mm Hg).

Management

- Treat the underlying disorder.
- Correct hypoxia.
- Treat hypokalemia and hypochloremia, if present.

CHAPTER 4

Trauma

INTRODUCTION

The role of anesthesiologist in the management of trauma is vital to resuscitate and to give critical care and also for anesthetic care, whenever needed.

There may be various types of trauma.

- Blunt trauma as in fall from a height, blow by some blunt object, motor vehicle accident.
- Penetrating trauma as in stab wound, gunshot wound, injury caused by sharp-pointed objects/weapons.
- Blast injury from explosion.
- Crush injury from motor vehicle injury.
- Burns from thermal, chemical or radiation injury.
- Cut injury from sharp objects/weapons/instruments.

According to the site of injury, there are other varieties too, such as head injury, abdominal or thoracic injury, etc. and these injuries can occur singly or in combination.

Some patients may be otherwise healthy at the time of injury and some may have concomitant problems accompanying trauma like toxic ingestion or intoxication. Some other patients may have concomitant and pre-existing disease like diabetes, hypertension, angina, ischemic heart disease, epilepsy and so on. Thus history should be extracted from the patient, if he is conscious and cooperative, otherwise relatives, neighbor, friends and others can be of some assistance. They may give some clue to pre-existing illness, if any. Some patients may have special bracelet or identification card indicating specific disease the patient suffers.

Assessment

A rapid physical examination is most important, the respiratory system and cardiovascular system in particular. Cardiac examination should include auscultation for any evidence of gallops, rubs, murmurs, thrill or ectopic beats.

Pulmonary examination can detect rales, wheezes and any evidence of COPD. Abdominal examination is also helpful to detect intra-abdominal disease. Extremities should be examined to detect any fracture, dislocation, injury and neurovascular integrity.

Laboratory investigations should always be done, if sufficient time permits. These should include—

- Electrocardiogram.
- Chest X-ray. X-ray of pelvis and spine.
- Blood urea, NPN, sugar, creatinine, electrolytes.
- Liver function tests.
- Prothrombin time, platelet count, hematocrit.
- Blood gas analysis.
 - Check the airway patency, breathing and circulation.
 - Check the vital signs: Pulse, respiration, blood pressure, central venous pressure.
 - Identify the cardiovascular and pulmonary derangements, if any.
 - Neurologic, vascular and airway problems need urgent consideration.
- Role of the first aider for immediate resuscitation to tackle the critical condition of trauma patient is most vital.
- Airway should be cleared and be kept patent. It can be done by
 - Neck extension, jaw thrust.
 - Oral/nasal airways.
 - Endotracheal intubation.
 - Transtracheal oxygenation.
 - Tracheostomy.
- *Breathing:*
Ventilation through patent airway

- *Circulation:*
 - Stop bleeding
 - IV infusion to raise blood pressure
- Diagnosis
- Evaluation of the patient from head to toe

Anesthetic Management for Trauma Patients in General

- All trauma patients should be regarded to have full stomach. Every attempt should be made for prevention of vomiting, regurgitation and aspiration pneumonia.
- Adequate cardiovascular resuscitation is vital.
 - IV infusion of fluids.
 - Vasopressors.
- *Induction of anesthesia:*
 - Awake intubation.
 - Rapid sequence induction with cricoid pressure.
 - Facemask ventilation.
 - Laryngeal mask ventilation.
 - If airway control is lost, transtracheal cannulation and jet ventilation
 - Cricothyrotomy.
 - Tracheostomy.
- *Drugs used for induction:*
 - Thiopentone, ketamine
 - Suxamethonium, mivacurium, atracurium.
- *Maintenance of anesthesia:*
 - Depends on the patient's condition, cardiovascular status, pre-existing disease.
 - Avoid vasodilating, myocardial depressant drugs.
 - Nitrous oxide + oxygen + narcotic + muscle relaxant method is mostly satisfactory.

- *Monitoring:*
 - Precordial stethoscope.
 - Blood pressure measurement.
 - Pulse oximeter.
 - Electrocardiogram.
 - Central venous pressure.
 - Pulmonary artery catheter.
 - Arterial blood gas analyzer.
- *Recovery:*
 - Adequate decurarization is essential, if nondepolarizing muscle relaxants are used.
 - Extubation should be done after complete return of airway reflexes.
- *Postoperative care:*
 - Monitoring of vital signs to be continued.
 - Oxygenation.
 - IV fluid should be judicious. Blood transfusion may be needed. Intake output chart should be maintained.
 - Nutritional care, care for the eyes, skin, bowel and urinary bladder.
 - Hypoxemia and hypotension can occur. Oliguria is not uncommon in postoperative period.
 - Antibiotics for prevention of sepsis.
 - Analgesics.
 - Regional analgesia for postoperative pain relief.
- *Role of regional anesthesia in trauma patients:*
 - Regional anesthesia may be satisfactory in selected cases provided:
 - i. Hemodynamic stability is maintained.
 - ii. No coagulation defect detected.
 - iii. Planned surgery decided.
 - iv. Asepsis and sterility of equipment guaranteed.
 - Suitable for limb surgery, orthopedic trauma.
 - Not suitable for major intra-abdominal trauma/chest trauma.

HEAD TRAUMA/INJURY

- Patient with head injury is usually unconscious.
- Needs airway support.
- May require cardiovascular and respiratory support.
- Continuous monitoring of vital signs.
- Needs special investigations.
- Skilled care and management.
- May be associated with other injury, coexisting medical disease.

Effect of Trauma to the Brain

- Skull and its contents may be affected by acceleration/ deceleration forces causing contusions at the site of impact and/or contracoup. It may affect the inner structures within the brain.
- Intracerebral and/or subdural hemorrhage can occur. Hematoma within the skull will cause increase in intracranial pressure and even brain shift.
- *Fracture of the skull:* Depressed fracture needs elevation. Fracture at the base of skull may cause bleeding in nasopharynx with subsequent aspiration of clots. Fracture of nasal bones may cause bleeding through nose. Risk of ascending infection is always there.
- *Extradural hematoma:* Typical history of blow over the temporal region and there is loss of consciousness. Evacuation through a burr hole under anesthesia improves the condition.
- *Cerebral edema:* It is associated with increased ICP, increasing coma, fixed dilated pupils and respiratory failure.
- Local tissue damage of brain produces local tissue acidosis and profound vasodilation. These vessels becomes unresponsive to changes in PaCO_2 . Hypercarbia causes vasodilation in normal regions of brain and divert

blood from injured part which have a luxury perfusion. Thus the damaged area becomes devoid of blood supply and overall ICP increases. IPPV may be helpful as it results in hypocapnia and the reverse situation develops. It helps to reduce ICP and divert blood to perfuse the traumatized brain tissue.

- Hypoxia, hypercarbia, straining, coughing, vomiting, etc. can increase ICP. Thus gentle smooth laryngoscopy and endotracheal intubation are needed for IPPV. Suxamethonium can increase ICP. Topical analgesia may prove useful.
- General anesthesia may be required in cases of
 - Carotid angiography.
 - CAT scan.
 - Surgical exploration.
- *Initial management:*
 - Secure a patent airway.
 - Mouth and pharynx to be sucked and cleaned.
 - Endotracheal intubation and oxygenation in unconscious patient.
 - Stomach should be emptied by suction through Ryle's tube.
 - Stop the hemorrhage.
 - IV infusion of fluids.
 - Care of the eyes.
 - *Examine the patient thoroughly*
 - i. Level of consciousness.
 - ii. Neurological examination.
 - iii. Pupil size equality, reaction to light.
 - iv. *Vital signs:* Pulse, respiration, blood pressure, body temperature.
 - v. Associated other injuries.

- Signs of raised ICP
 - i.. Decreased level of consciousness.
 - ii. Bradycardia.
 - iii. Rise of blood pressure.
 - iv. Pupils dilated. unequal, nonacting to light.
 - v. Altered respiratory pattern, apnea.
- *Monitoring:*
 - Vital signs: Pulse, respiration, blood pressure.
 - Eye signs.
 - Level of consciousness.
 - Intracranial pressure.
 - X-ray of skull.
 - Brain CT scan.
 - Carotid angiography.
 - EEG.
- *Treatment:*
 - Steroids.
 - IPPV.
 - Control of body temperature.
 - Control of cerebral edema.
 - Nursing care, nutritional care.
- *Anesthetic considerations:*
 - Conscious patients with more or less normal breathing needs only supplemental oxygen.
 - Unconscious patients should be intubated and ventilated.
 - Intubation can be done with rapid sequence induction with cricoid pressure.
 - In suspected cases of cervical spine fracture, in-line head stabilization is mandatory. Neck extension and mouth opening should be cautious.
 - Suxamethonium can increase ICP.
 - Nasogastric or nasotracheal intubation is contraindicated in fracture base of skull.

- Hypoxia and hypercarbia should always be avoided. Blood pressure should be maintained near normal.
- Diuresis is always helpful to decrease ICP.
- Undue hypotension and tachycardia may indicate some concealed hemorrhage in other parts of body.
- Hypertension and bradycardia will indicate increased ICP.

FACIAL TRAUMA/INJURY

- Upper airway obstruction can occur due to blood, vomitus, broken teeth, secretions, etc. This needs urgent airway protection and oxygenation.
- Aspiration of foreign bodies, vomitus, etc. can also occur.
- It can pose difficult intubation due to limited movement of temporomandibular joint, restricted mouth-opening, edema of tongue, etc.
- Nasogastric or nasotracheal intubation should not be done in cases with nasal trauma, fracture base of skull.
- It may be further complicated with open eye injury.

NECK TRAUMA/INJURY

- It may be associated with some major problems:
 - Fracture cervical spine.
 - Airway obstruction/disruption, hypoxemia, dysphonia.
 - Hemorrhage, hemoptysis.
 - Esophageal injury, dysphagia.
 - Cut-throat injury.
 - Hanging: Laryngeal fracture, airway disruption.
 - Subcutaneous emphysema.
 - Air embolism.
 - Pneumothorax.
 - Major vascular injury: Hemorrhage.

- These patients need instant attention, care and resuscitation.
- Secure a patent airway, tracheobronchial toilet, oxygenation. IPPV following endotracheal intubation. Tracheostomy may be needed in some cases.
- Stop hemorrhage as far as practicable IV infusion of fluids, blood transfusion.
- Preventive measures of air embolism.

CHEST INJURY

- It may cause injury to one or more intrathoracic organs including lungs, heart and big vessels.
- It can produce severe shock which demands immediate care and treatment. It may be due to massive hemorrhage and altered cardiopulmonary dynamics.
- Patient may be in respiratory distress which needs instant evaluation and management.
- Risk of air embolism is always there.
- Pneumothorax and hemothorax can occur.
- There may be coexisting other ailments too.

Blunt Injury of Chest

- Fracture ribs can damage the surrounding structures causing intense pain, shallow respiration, retained secretion, atelectasis, bronchopneumonia, lung abscess and so on.
- Rib fractures may cause pneumothorax, flail chest, liver/spleen puncture.
- Problems become manifold when the patient is elderly or complicated with coexisting lung diseases like asthma, COPD, bronchiectasis, etc.
- Subcutaneous emphysema indicates disruption of larynx, trachea or bronchus or lung.

- These patients need
 - Adequate analgesics.
 - Tracheobronchial toilet.
 - Bronchoscopic suction.
 - Pain relief by continuous extradural block/intercostal block, adequate strapping over the chest.
 - Mechanical ventilation in severe cases. It avoids paradoxical respiration. It is also indicated in cases of lung injury or when associated with other injuries. But there is always risk of pneumothorax. Chest drain should be considered.

Pneumothorax

- Air in the pleural cavity is mostly due to disruption of alveoli following penetrating injury of chest. Rupture of esophagus, trachea or even bronchus may also cause it.
- A small pneumothorax may not need chest drain and can be efficiently managed by conservative treatment. But surgical emphysema and need for IPPV indicate chest drain.
- Chest drain is usually in the midclavicular line at second intercostal space. Tube should be attached to a water seal drain. Chest drain should be removed once air bubbling stopped provided the lung is fully expanded.
- In case of failure to expand lung despite adequate suction and serious bubbling occurring through the drain, bronchoscopy should be done to exclude bronchial rupture. Manifestations of pneumothorax include cough, tachypnea, dypnea, hypoxemia, cyanosis, tachycardia and chest pain.
- Before induction of anesthesia, pneumothorax and/or hemothorax chest tube drainage is essential.
- Nitrous oxide should be avoided in cases of pneumothorax, oxygen 100% should be given.
- Circulation should be supported by IV infusion of fluids and vasopressors.

Hemothorax

- Hemothorax is diagnosed by a chest X-ray in erect posture showing opacity. Fluid level can be seen in presence of blood and air.
- In presence of hypotension and shock, adequate IV infusion and blood replacement are essential.
- Blood should be drained through a drainage tube usually inserted in 8th intercostal space about 4 inches from vertebral column.
- Exploratory thoracotomy may be indicated in some cases. Bleeding from the lung should be stopped. Any other injury, if detected can also be tackled.

Flail Chest

- It is caused by fracture of the anterior and posterior ends of several ribs causing a mobile segment of chest wall which is sucked in during inspiration and blows out during expiration.
- *Manifestations:*
Deep labored respiration, rapid respiration, greater movement of flaccid segment, hypoxia, hypercarbia, exhaustion.
- Flail chest can occur in both sides, may even be central. Associated other injuries may also be present.
- *Management:*
 - *First aid measure:* Flail segment should be manually supported. Patient should be rolled on to the affected side.
 - Endotracheal intubation and IPPV are mostly appropriate. Long-term IPPV is needed.
 - Analgesia. Continuous epidural block is mostly helpful.

Diaphragmatic Rupture

- It is usually caused by violent abdominal compression.
- Left side of diaphragm is most vulnerable. Right side is mostly protected by liver.
- Usually stomach and intestine enter into the thoracic cavity.
- Chest X-ray will show gas shadows inside the chest.
- Emergency thoracotomy may be needed to reduce the viscera and repair of diaphragmatic tear.

Injury to Heart and Great Vessels

Most of the wounds of the heart and great vessels end fatally. Direct trauma to heart is associated with fracture sternum, cardiac tamponade, tachyarrhythmias and ischemia. Myocardial contusion is diagnosed by echocardiography. Aortic injury may reflect widened mediastinum on chest X-ray. Surgical measures (repair) will include the facility of cardiopulmonary bypass. Maintain the circulating blood volume by administering IV fluids (crystalloid, colloid, blood) and perfusion pressure by administering vaso-pressors as needed.

PULMONARY FAT EMBOLISM

- It is a severe life-threatening complication of trauma commonly associated with fracture of long bones.
- A pulmonary embolism is a partial or complete obstruction of the pulmonary arterial circulation by substances (fat, air, etc.) originating elsewhere in the cardiovascular system.
- *Manifestations:*
 - Dyspnea, pleuritic chest pain, hemoptysis.
 - Widespread petechial hemorrhages in the skin, conjunctiva and fundi.
 - Hypoxemia, rales, wheeze, pleural rub.

- Disseminated intravascular coagulation, thrombocytopenia, bleeding.
- Fat globules may be seen in urine, sputum, or retinal vessels.
- X-ray chest.
- Blood gas changes.
- *Management:*
 - Adequate oxygenation and ventilation, endotracheal ventilation, IPPV with PEEP, increase the arterial oxygen saturation.
 - Expand the circulating fluid volume.
 - Inotropic drugs.
 - Correction of hypoxemia.
 - Steroids.
 - General management of shock.

INJURY OF BONES

- Fracture and dislocation of bones are common following trauma and these may be associated with injury to surrounding structures. Muscles, vessels and nerves may be involved. Immediate surgical exploration is indicated in such cases.
- Injury of vessels may cause excessive bleeding and produce shock. Early vascular resuscitation is essential particularly before induction of anesthesia.
- Pressure on vessels by bone fragments may cause ischemia and necrosis. This needs early surgical intervention.
- Fracture of pelvic bones may cause severe bleeding and may be associated with injury other viscera. Early immobilization, fixation and even surgical intervention may be indicated.
- Fracture of long bones and massive trauma may cause fat embolism.

- Fracture and dislocation of vertebral column is very serious and may cause limb paralysis. Fracture cervical spine needs immediate care and in-line head stabilization. Intubation should be extremely cautious.
- Fracture neck femur mostly occurs in elderly patients and there may be other coexisting medical illness.
- Crush injuries can liberate potassium and myoglobin. Suxamethonium should be avoided in such cases.
- Regional block may be useful for orthopedic manipulations particularly of the limbs.

Intra-abdominal Injury

- Blunt abdominal trauma may cause injury to spleen, liver, stomach, intestines, abdominal wall, retroperitoneal vessels, mesentery, pancreas, diaphragm, lung, esophagus and ribs. Blunt trauma presents greater problems in diagnosis.
- These may be associated with other injuries like head injury, chest injury and fractures.
- Penetrating injuries and gunshot injuries are also common.
- There may be abdominal pain, rigidity of abdominal muscles, peritonitis, intra-abdominal hemorrhage, blood in the nasogastric tube suction, blood in peritoneal lavage, shock.
- These patients should always be treated as full stomach. Paresis of the gut almost always occurs.
- The patient is often toxic, hypovolemic and dehydrated. Electrolyte disturbances and metabolic acidosis are often present.
- Abdominal wounds particularly penetrating type with peritoneal involvement needs surgical exploration. All gunshot wound should be explored under general anesthesia. In case of impacted penetrating object, it should be removed in operating room under general anesthesia to control bleeding.

- *Anesthetic management:*
 - Assess the cardiovascular status, dehydration and toxemia.
 - Enquire about any coexisting disease.
 - *Investigations:* Hematocrit Hb%, serum electrolytes, urine analysis.
 - IV infusion of fluid. A CVP line is essential.
 - Blood transfusion may be needed.
 - Nasogastric tube suction.
 - No premedication is usually needed.
 - Preoxygenation, crash induction with cricoid pressure.
 - Endotracheal intubation. Inflate cuff properly. IPPV.
 - *Maintenance of anesthesia:*
N₂O + O₂ + vecuromium/atracurium. Small doses of volatile anesthetic such as 0.5% halothane can be used.
 - Monitoring of vital signs; ECG, CVP, BP, pulse, urinary output.
 - Reversal of block should be adequate at the end of surgery.
 - Evacuate stomach before extubation.
 - *Postoperative care:*
 - i. Oxygenation
 - ii. Maintenance of IV fluid therapy
 - iii. Analgesics.

CHAPTER 5

Burns

Burns can occur from thermal, electric, chemical and radiation sources. Thermal injury/burns causes damage to skin and underlying tissues. Electrical burns damage large area of muscle mass and chemical burn injury depends on the chemical substance, its concentration and duration of exposure.

THERMAL BURNS

Burns is graded as first, second and third degree.

- *First degree*: Simple erythema of skin, only destruction of superficial layers of epidermis. This is reversible.
- *Second degree*: Partial thickness burns extends through epidermis to dermis. Here regeneration can occur from epithelial cells surrounding hair follicles or sweat glands.
- *Third degree*: Total (full) thickness burns. Here irreversible destruction of all the skin, dermal appendages and epithelial elements occur. To avoid the formation of scar, skin grafting is needed.

Extent of Burn Injury

It is expressed as a percentage of total body surface area suffering second or third degree burns. It is commonly estimated by the *rule of nines* as follows:

Head and neck 9%

Upper extremity (right and left) $9 \times 2 = 18\%$

Lower extremity (right and left) $18 \times 2 = 36\%$

Trunk anterior 18%

Trunk posterior 18%

Perineum 1%

- In infants this formula is modified to allow for the relatively larger head surface area.
 - Upper limb (right and left) $10 \times 2 = 20\%$
 - Lower limb (right and left) $10 \times 2 = 20\%$
 - Head 20%
 - Front of trunk 20%
 - Back of trunk 20%

Pathophysiology of Major Burns

- It destroys the skin, the largest organ of the body and affects thermoregulation, fluid and electrolyte homeostasis and protection against infection.
- In the early stage, excessive fluid loss occurs from vascular compartment into the affected burn wound. Sequestration in extravascular space causes hemoconcentration, cardiovascular collapse and severe shock.
- Increased secretion of antidiuretic hormone (ADH) may reduce the urinary output.
- Plasma protein particularly albumin is lost through the wound.
- The metabolic rate is increased. Oxygen consumption and CO_2 production are also increased. Hypermetabolic state continues till completion of tissue repair.
- Vascular integrity changes in the body and capillary leak is common producing edema. Severe pulmonary edema can occur.
- Pulmonary function deteriorates. Functional residual capacity, lung compliance, chest wall compliance decrease. The alveolar-arterial oxygen gradient increases. Minute ventilation is increased.
- Patients with extensive burns may suffer from prerenal azotemia. Acute tubular necrosis can occur due to hemolysis from thermal burns and myoglobin from electrical burns. Renal failure can be prevented by alkalinization of urine and forced diuresis.
- Sepsis is common in burns. It can predispose DIC.

The prognosis mostly depend on

- Age.
- Extent and depth of burns.
- Associated other injuries.
- Associated co-existing disease.

Suxamethonium is contraindicated in burned patients as it can cause a significant increase in serum potassium and cardiac arrest. This effect begins about 5-15 days after burn injury and may persist for 2-3 months irrespective of extent and depth of burns. This response may be due to increased chemosensitivity of the muscle membrane which is due to development of receptor sites in extra-junctional areas.

Smoke Inhalation

- It usually occurs in patients when burned within an enclosed space, and/or received burns of the face. Plastic materials increases the chance of inhalation of toxic fumes.
- These patients may be under the influence of alcohol/drugs or comatose at the time of accident.
- There may not be any physical sign or symptom during first 24 hours postburn.
- *Manifestations of respiratory tract injury:*
Burned nasal hairs, nasal mucosa, lips, and mouth, hoarseness, bronchospasm, wheezing, brassy cough, soot in sputum. Loss of surfactant, atelectasis and edema lung can occur. Congestion of posterior pharynx, edematous larynx. X-ray chest may be negative in early stage. Myocardial damage can occur from release of toxins. Airway edema can cause airway obstruction.
- Laboratory tests should include blood gas analysis, carboxyhemoglobin level, serum electrolytes, serum lactate level, oximetry, fiberoptic bronchoscopy.
- *Management:*
 - Adequate ventilation and oxygenation.
 - Early endotracheal intubation and IPPV.
 - Tracheobronchial toilet.
 - Steroids in large doses.
 - Antibiotics.
 - Cautious IV fluid therapy.
 - Nursing care, nutritional care.

Resuscitative Measures of Burn Patient

- IV fluid infusion is essential to resuscitate the burned patient immediately. This is mostly to treat hypovolemia and to ensure good tissue perfusion and adequate urine output.
 - Crystalloid solution in the first 24 hours.
 - i. Adult: 4 ml/kg/percent body surface burned.
 - ii. Children: 3 to 4 ml/kg/percent body surface burned.

Half of the estimated volume should be given in first 8 hours and the rest over the next 16 hours. Normal maintenance fluids are administered in addition. Urine output should be maintained at 30 to 70 ml/hour.
 - Colloid solution after the first 24 hours; 5% albumin, plasma and plasma substitutes. The following should be given over 24 hours: 0.3 to 0.5 ml of colloid/kg/percent body surface burned + 1.5 ml of Ringer lactate/kg/percent body surface burned + 2000 ml of glucose in water. Urine output should be maintained at 30 to 100 ml/hour.
- Hourly maintenance crystalloids are needed to the calculated colloid replacement volume. Additional fluid may be necessary in presence of hemodynamic instability and inadequate urine output.
- Maintain the airway to ensure adequate ventilation and oxygenation.
- In cases of airway burns, endotracheal intubation and IPPV are indicated.
- Antibiotics.
- Prophylaxis against tetanus.
- Nursing care, care of the wounds, care of eyes, bowel and urinary bladder.

- Adequate monitoring of vital signs. Hematocrit, serum electrolytes, blood gas analysis, CVP, etc. are essential.
- Basal metabolic rate increases enormously in extensive burns due to hypercatabolism. Intravenous nutrition is helpful.
- Tracheostomy may be needed in severe cases of airway burn.
- Pulmonary complications such as ARDS are common in extensive burns. Ensure adequate preventive measures.
- Circumferential chest scars can cause restrictive lung disease with atelectasis, reduced FRC and hypoxemia.

Anesthetic Considerations

- *Problems:*
 - Early extensive excision and skin grafting cause profuse blood loss. Adequate blood transfusion is needed.
 - Facial burns, airway burns, airway edema and neck contracture may pose difficult intubation. Tracheostomy may be needed in extreme cases.
 - Intravenous cannulation may be difficult.
 - Drug effect and tolerance may vary.
 - Drugs causing hypotension should be avoided.
 - Suxamethonium is contraindicated in burned patients as it causes hyperkalemia.
 - Patients with extensive burns need critical care management.
- Induction of anesthesia should be cautious. Hypotension should be avoided. Ketamine can be used. Mivacurium or large dose of vecuronium is good when suxamethonium is contraindicated.
- *Maintenance of anesthesia:* Nitrous oxide, oxygen and intermittent doses of opioid and relaxant technique is mostly satisfactory. Vasodilating anesthetics and myocardial depressant drugs should be avoided.

- At the end of surgery, adequate decurarization should always be done.
- IV fluid infusion should be adequate.
- Blood loss should be replaced.
- Avoid hypoxia and hypotension in postoperative period.
- Postoperative analgesia is needed in adequate doses.
- Monitoring is vital during and after anesthesia.
 - Electrocardiogram.
 - Arterial catheter to measure blood pressure and multiple blood sampling.
 - Central venous pressure.
 - Pulmonary artery catheter in patients with left ventricular dysfunction.
- Heat loss is common. The operation theater and recovery room should be warm and kept comfortable.

CHEMICAL BURNS

- Acid, alkali and petroleum, etc. can cause severe burn injury. Caustics include acids and alkalies. Alkalies are common ingredients in cleaning agents, washing powders and pain removers.
- Acids produce a coagulative necrosis and alkalies cause a liquefactive necrosis.
- Petroleum can cause burns in the absence of flames.
- Degree of chemical injury depends on the particular agent, its concentration, its volume and duration of contact.
- Acids and alkalies, if taken by mouth can cause intense pain in oropharynx, chest and abdomen, dysphagia, respiratory distress, airway edema. Tracheal aspiration, gastroesophageal bleeding and perforation can also occur.

- Hydrofluoric acid causes intense pain and severe deep injury at the site of exposure. There may not be any obvious skin burns. Fluoride intoxication can cause renal dysfunction.
- Acid/alkali burn should be managed with the following:
 - Remove the clothing; affected skin should be washed.
 - Brush the powdered material of the skin.
 - Irrigate with large amount of water.
 - Airway management, IV fluid therapy, antibiotics.
 - Monitoring.
 - Nutritional care, adequate nursing care.

ELECTRICAL BURNS

- It can occur in high voltage electricity or lightning.
- Usually, there are small areas of injury at the entry and exit, but with large massive injury inside. Muscles are necrosed causing myoglobinemia, myoglobinuria and eventually renal failure.
- Myocardial damage, conduction defect, altered cardiac function can also occur.

RADIATION INJURY

- It depends on the type of radiation.
- It can penetrate the deep tissue layers and affect the body systems.
- Adequate preventive measures should be taken while working in radiation prone zone.

SPECIAL ANESTHETIC PROBLEMS IN ACUTE BURNS IN CHILDREN

- Children tolerate burns very badly.
- Airway and pulmonary damage can cause airway obstruction and respiratory failure.

- Fluid balance is most important to maintain renal function.
- Body temperature should be maintained near normal.
- Acute gastric dilation is common. Regurgitation can occur.
- Early infection is common.
- Monitoring may be difficult in extensive burns.
- IV infusion may be problematic due to lack of proper site for injection.
- Anesthesia is mostly needed for tracheostomy, early burns dressing, escharectomy, etc.

CHAPTER 6

Anesthesia for Surgical Emergencies in Neonates, Infants and Children

The neonate is defined as a baby during the first 28 days of life. Certain conditions and congenital defects may need surgery during neonatal period. Incomplete adaptation of the baby to the extrauterine environmental conditions may significantly complicate the situation. Some special considerations and provisions for the neonates demand attention for their anesthetic care.

NEONATAL PHYSIOLOGY

Neonates differ from adults in various ways particularly in the airway, respiratory system, cardiovascular system, hepatorenal system, blood and metabolism.

- *Airway:* Neonates are obligate nose breathers. Tongue is relatively bulky. Larynx lies roughly at C_3C_4 , more cephalad compared to adults (C_4 , C_5). Epiglottis is narrower, vocal cords are slanted to trachea, cricoid is the narrowest part of larynx. Occiput is relatively large. The airway is small and narrow and mild edema or secretions can block the airway and impair the gas flow.
- *Respiratory system:* Neonatal lungs are less efficient. Ribs are more horizontal and the diaphragm is pushed up by the liver. Physiological dead space is increased. Muscles of respiration are ill developed and can fatigue easily; respiratory pattern is variable. Respiratory rate varies from 34 to 40/min. Tidal volume is about 20 ml on average. Respiratory reserve is diminished.
- *Cardiovascular system:* Profound hemodynamic alterations occur at birth with closure of ductus arteriosus and foramen ovale. Persistent patent ductus arteriosus and patent foramen ovale shunt blood away from lungs and into the systemic circulation. It is more so in presence of hypoxemia, hypercarbia, acidosis or high airway pressures.

Blood pressure of neonate is roughly 80/60 mm Hg and heart rate varies from 120 to 140/min. Cardiac output is high to meet the demands of high metabolic rate. Bradycardia is common and often causes hypotension.

- *Hepatorenal system:* The system is mostly immature at birth and their functions are not efficient. Hepatic drug metabolism is much limited. Jaundice in neonate is common. Hypoglycemia and hypocalcemia occur frequently. Renal function is poor. Glomerular filtration rate and removal drug clearance diminish. Concentrating power is also limited.
- *Blood:* Hemoglobin content of blood is high but more than 50% exists as fetal hemoglobin (HbF). HbF can hold Hb more than adult Hb and causes little leftward shift of oxygen dissociation curve. Blood volume is roughly 90 ml/kg. Hematocrit varies from 50 to 60%. Physiological anemia is common.
- *Metabolism and thermoregulation:* Heat loss and energy expenditure are minimum in thermoneutral environment; 34°C in permatures and 32°C in neonates and 28°C in adults. It is needed to raise the environmental temperature to reduce the heat loss in neonates. Responses to cold environment increases the metabolic activity. Neonates depend on nonshivering thermogenesis from increased metabolism of brown fat controlled by the sympathetic nervous system.

Oxygen consumption is increased throughout infancy declining gradually in later childhood.

Neonates has greater surface area to volume ratio (2.5 times greater than the adult) allowing greater area for heat loss.

- *Central and autonomic nervous system:*
 - Brain of neonate is about 12% of body weight and receives about 34% of cardiac output.

- Blood-brain barrier is more permeable to lipid soluble molecules.
- In newborn, parasympathetic system seems to be well developed, but sympathetic system may not be fully mature till 4-6 months of age.
- *Fluid balance:* In neonates the extracellular fluid is 35% of body weight, intracellular fluid is 40% and in plasma 5%, the total being 80% of body weight.

In infants, the extracellular fluid is 30% while the fluids in other compartments remain the same. The ratio of total body water in extracellular space exceeds that in intracellular space. This ratio reverses gradually with increasing age. The turnover of fluid is always greater in infants than in adults.

Restriction of fluid intake in infants results dehydration rapidly.

As renal function is immature in neonates and infants, drugs excreted by kidneys may cause cumulation and toxicity. Reduced doses and/or increased dose intervals may be needed.

Normal Average Values of Neonates

- Heart rate 120 beats/min.
- Respiratory rate 30 to 40 times/min.
- Blood pressure 60-90/40-60 mm Hg.
- Body temperature 37.4°C (rectal)
- pH 7.2 to 7.35; 7.4 at about 1 week.
- PaO₂ 50 mm Hg at birth, 75 mm Hg at about 1 week.
- PaCO₂ 48 mm Hg at birth; 35 mm Hg at about 1 week.
- Tidal volume 6 ml/kg.
- Dead space 2 ml/kg.
- Alveolar ventilation 150 ml/kg/min.
- Urinary output 0.5 to 1 ml/kg/hour.
- Hematocrit 50 to 60 percent.

EQUIPMENT FOR PEDIATRIC ANESTHESIA

This is mostly similar to that used for adults, but size should be modified according to the need.

- Mask should be of proper size and shape. It should properly fit around the face. It should have minimum dead space. Clear transparent variety can easily identify the excessive secretions or vomitus.
- Oral airways come in a variety of sizes. Properly sized oral airway can provide adequate patency of airway. It should be neither of too short nor too long. It should not cause obstruction and irritation on the airways. Nasal airways should be of adequate size. Small lumen can cause high resistance of gas flow.
- Infants should always be intubated. Straight blade laryngoscopes are mostly popular for pediatric cases.
- Uncuffed PVC endotracheal tubes are mostly used. The endotracheal tube should fit through cricoid ring with a minimum leak. Size of the endotracheal tube should be according to the formula after the age of 4 years:

$$(\text{age in years}/4) + 4 \text{ in mm ID}$$

Usually the proper sizes are:

For prematures 2.5 to 3 mm.

For full-term baby 3 to 3.5 mm.

For baby 3 to 7 months: 3.5 mm.

For baby 6 to 20 months: 4 mm.

For baby 2 years of age: 4.5 mm.

- Cuffed endotracheal tubes are mostly used in children over 5 years of age.
- The length of endotracheal tube is usually calculated as $\text{age in years}/2 + 12 \text{ cm}$.
- Stylet can be used cautiously to facilitate intubation.
- Magill forceps in pediatric sizes are helpful.
- Suction catheters should be readily available.

- Anesthesia machine should be of good order with all its accessories and well-equipped with monitors. Ventilators can be used with small bellows and these should provide all necessary parameters for pediatric use.
- *Breathing system*: Jackson-Rees modification of Ayre's T piece or Bain circuit can be used for infants weighing less than 10 kg as these are light, simple and provide no valves or CO₂ absorbers. But during use, fresh gas flow should be 2.5 to 3 times the minute volume to prevent rebreathing. Circle system can be used in older children. Here unidirectional valves prevent rebreathing and CO₂ absorber eliminates CO₂ and preserves heat. But controlled ventilation is always recommended during use of pediatric circle system.
- Monitoring is essential during pediatric anesthesia. Precordial or esophageal stethoscope is very helpful to note heart rate, rhythm along with breath sounds. Blood pressure should be evaluated in the usual manner. Other monitors should include electrocardiogram, pulse oximetry and capnography. Blood gas study and neuromuscular monitoring may be needed in selected cases. Monitoring of body temperature and urine output is also useful. Urine output of 0.5 to 1 ml/kg/hour usually indicates adequate renal perfusion.

ANESTHESIA INDUCTION TECHNIQUES

- The techniques depend on the age, size, physical condition and risk of aspiration.
- Premedication is not always necessary, but it is better to administer atropine sulphate before induction of anesthesia.
- Awake intubation may be effective in selected cases, but the technique seems to be difficult and can cause trauma to airway.

- Rectal induction with methohexitone is not used nowadays.
- Inhalation induction is much popular. It can be done with N_2O , O_2 and halothane/enflurane/isoflurane.
- Intravenous induction is also popular. Preoxygenation and administration of atropine should always be done.

Common IV Inducing Agents

- Thiopentone 4 to 6 mg/kg.
- Ketamine 1 to 2 mg/kg.
- Propofol 2.5 to 3.5 mg/kg.

Muscle Relaxants in Common Use

- Suxamethonium 2 mg/kg.
- Vecuronium 0.2 mg/kg.

Other Commonly Used Drugs

- Atropine 0.02 to 0.04 mg/kg.
- Pancuronium 0.1 mg/kg.
- Fentanyl to 2 mg/kg.
- Morphine 0.05 to 0.1 mg/kg.
- Adrenaline 10 mg/kg.
- Calcium chloride 10 to 30 mg/kg.
- Sodium bicarbonate 1 to 3 mEq/kg.

FLUID THERAPY

- Fluid status should be well-evaluated before administration of anesthesia. Coexisting conditions such as fever, vomiting, diarrhea, etc. can cause excessive water loss and dehydration.
 - Poor skin turgor denotes 5% loss of water.
 - Sunken fontanels, tachycardia, oliguria denote 10% water loss.
 - Sunken eyes, hypotension indicate 15% dehydration.
 - Coma indicates 20% dehydration.

- Electrolyte status also needs attention. Hypovolemia and hypoxia can cause acidosis. This should be evaluated and treated before anesthesia.
- Preoperative fasting needs proper justification with the aim to minimize gastric volume and dehydration. No solid fluid should be allowed for 8 hours, but clear liquids can be given upto 2 hours before anesthesia.
- Maintenance fluid scheme should be as follows:
 - Upto 10 kg: 4 ml/kg/hour.
 - 10 to 20 kg: 40 ml + 2 ml/kg/hr.
 - Above 20 kg: 60 ml + 1 ml/kg/hr.
- It should be noted that hypermetabolic states like fever increase the fluid requirement and it is said that for each 1°C above normal temperature can increase fluid requirement by 10%.
- Surgery causes fluid loss depending on tissue surface exposure and degree of trauma as follows:
 - Superficial exposure: 0 to 2 ml/kg/hr.
 - Mild-to-moderate exposure: 3 to 5 ml/kg/hr.
 - Large abdominal/thoracic exposure: 10 to 15 ml/kg/hr.
- Normal saline or Ringer's lactate is the most popular and efficient replacement fluid in infants. For maintenance fluid therapy, glucose containing fluids are recommended.
- Blood replacement should be cautious and judicious. It should be guided by assesment of blood loss, hematocrit, physical condition and tolerability. About 10% blood loss can be well managed with adequate fluids, but above that, it seems wise to replace the blood, ml for ml.
- Avoid massive blood transfusion as far as practicable. It may be associated with hyperkalemia, hypocalcemia, dilutional thrombocytopenia and hypothermia.
- *Note:* An intravenous infusion must be established preferably by cannulating the vein on the scalp, dorsum

of the hand or foot or the long saphenous vein at the ankle. Syringe pumps and controlled infusion are always helpful.

ANESTHESIA IN SPECIFIC CONDITIONS

Congenital Diaphragmatic Hernia

- It may be of several types but the commonest is left-sided Bochdalek (posterolateral type). Eventration is typed when the whole diaphragm is membranous. Hiatus hernia is situated at the esophageal opening which is congenitally widened, usually associated with short esophagus.
- *Clinical features:* Respiratory distress, cyanosis, mediastinal displacement, scaphoid abdomen, breath sounds absent on affected side, bowel sounds may be heard over the thorax. X-ray chest may confirm the diagnosis.
- May be associated with malrotation of gut, congenital heart disease, renal abnormalities, and neurologic problems.
- Prognosis depends on degree of maturity of the baby, degree of pulmonary hypoplasia, presence of other abnormalities, early detection and surgical, anesthetic and nursing care.
- Anesthetic management:
 - Correct hypoxemia and acidosis.
 - Maintain adequate ventilation. Administer humidified oxygen.
 - Avoid pneumothorax.
 - Baby is kept in semiupright, semilateral position inclined towards the affected side.
 - A Ryle's tube is passed and low suction is maintained to diminish further distention of viscera.

- No ventilation through bag and mask.
- Awake intubation and control ventilation with 100% O₂, curarization can be done after intubation.
- IV infusion, blood gas study, blood transfusion.
- *Anesthesia:*
 - i. Preoxygenation, awake intubation, induce anesthesia with oxygen and halothane/ isoflurane. Avoid N₂O.
 - ii. Airway pressure should be monitored. It should not exceed 25-30 cm H₂O.
 - iii. Following reduction of hernia lung expansion should not be tried. It may cause long damage.
- *Postanesthetic care:*
 - i. Baby may need continued ventilation. In presence of respiratory insufficiency, control the ventilation and positive end expiratory pressure (PEEP) may be needed in selected cases.
 - ii. Bilateral chest drains should be connected to under waterseal drainage.
 - iii. Continued gastric suction.
 - iv. Maintain fluid status properly.
 - v. Adequate nursing care.
 - vi. Correct acidosis, if present.

Tracheoesophageal Fistula and Esophageal Atresia

- These two conditions are interrelated and may present in various forms. The commonest form is esophageal atresia with a fistula between trachea and distal segment of esophagus. The H type fistula without atresia is also seen. Other varieties include both upper part and lower part of esophagus end blindly and there is no fistulous communication.
- Associated conditions may include prematurity, congenital heart disease, renal and genitourinary abnormalities.

- *Clinical features:* Excessive frothy mucus from the mouth, periodic cyanotic attacks, respiratory difficulty, persistent vomiting after each feed, pneumonitis, arrest of nasogastric tube at some part of esophagus, X-ray evidence of excessive air in stomach. X-ray with opaque dye through Ryle's tube shows blind pouch and in presence of fistula the dye may enter into the lungs.
- *Anesthetic problems:*
 - Aspiration can cause pulmonary problems.
 - Possibility of intubating fistula.
 - Anesthetic gas flow may pass into the stomach.
- *Preoperative care:*
 - Kept in semiupright position.
 - The upper pouch needs continuous suction.
 - IV fluid infusion. Blood should be kept ready.
 - Respiratory care, oxygenation.
- *Anesthesia:*
 - Awake intubation, the tube bevel should face posteriorly.
 - Oxygenation, tracheobronchial toilet.
 - Maintenance of anesthesia with N_2O , O_2 and halothane/isoflurane with spontaneous ventilation.
 - Muscle relaxant can be given when the chest is open and then institute controlled ventilation.
 - Careful monitoring of vital signs is essential.
- *Postoperative care:*
 - Extubation when the baby is well awoken. In presence of respiratory insufficiency, continue controlled ventilation.
 - Gentle suction of pharynx.
 - Adequate nursing care.
- *Complications:* Pulmonary infection, wound infection, aspiration, mediastinitis, leaking/rupture of anastomosis.

- Prognosis depends on maturity of the baby, associated abnormalities, type of fistula and its communications, availability of skilled surgical, anesthetic and nursing care in time.

Omphalocele and Gastroschisis

- Here herniation of abdominal contents occurs through the anterior abdominal wall. Gastroschisis is a defect of anterior abdominal wall lateral to umbilicus usually on right side and the umbilical cord is in normal position. It is mostly ruptured *in utero* and has no covering membrane.
- In omphalocele (exomphalos), there is herniation into the umbilical cord which is continuous with the apex of the sac. Sac may be intact or rupture before, during or after birth with prolapsed abdominal contents coming through it. It may be associated with other congenital defects.
- *Surgical care:*
 - Primary closure
 - In massive type when abdominal cavity is too small, only skin or silastic dacron closure temporarily and complete repair afterwards.
- *Anesthetic care:*
 - Delay of operation invites infection and further bowel distension.
 - Proper evaluation of the baby. Risk of hypovolemia, hypoglycemia and hypothermia.
 - A gastric tube helps decompression of the stomach.
 - IV fluid therapy. Blood transfusion may be needed.
 - Atropine sulphate IV at the time of induction.
 - Induction and maintenance of anesthesia with N_2O , O_2 and halothane/isofurane. Avoid N_2O as it may cause further bowel distension.
 - Muscle relaxants for controlled ventilation.

- Primary closure may cause respiratory and circulatory insufficiency.
- Extubation should be done when the baby is well awoken.
- *Postanesthetic care:*
 - i. Continued controlled ventilation.
 - ii. Maintain nasogastric suction.
 - iii. Continue IV fluid therapy.
 - iv. Adequate nursing care.

Congenital Pyloric Stenosis

- Common malformation of digestive tract causing gross-thickening of circular muscle of pylorus so much to cause obstruction of food passage.
- *Manifestations:* Palpable pyloric mass, projectile vomiting, vomitus contains no bile, dehydration, electrolyte and acid-base imbalance, loss of chloride from the stomach producing hypochloremic alkalosis and even tetany; hypokalemia, hypovolemia. X-ray abdomen following barium swallow may be useful for diagnosis.
- *Surgery:* Pyloromyotomy
- *Anesthetic care:*
 - Correction of dehydration and electrolyte and acid-base imbalance before surgery. Normal urine output should be established.
 - Risk of vomiting and aspiration.
 - Continuous gastric suction.
 - Atropine sulphate IV before induction.
 - 100% O₂ through facemask.
 - Awake intubation.
 - Induction and maintenance of anesthesia with N₂O, O₂ and halothane. Muscle relaxant for controlled ventilation.

- Baby should be well relaxed and immobile while the pyloric mass is split.
- Extubation while the baby is well awoken and in lateral position.
- Continue IV fluid containing glucose in postoperative period. Oral feeding is recommended with clear fluids, 6 to 12 hours postoperatively.

Intestinal Obstruction

Intestinal obstruction in neonates can result from various lesions such as duodenal atresia, malrotation, volvulus, duplication cysts, meconium plugs, meconium ileus and so on. It is common in cases of toxemia pregnancy, polyhydramnios and premature labor. Associated conditions may include prematurity, congenital heart disease, Down's syndrome, cystic fibrosis, subglottic stenosis. The possibility of intestinal obstruction is suspected when there is green stained vomiting by the baby or failure to pass meconium for 24 hours.

Duodenal atresia may be due to complete atresia, stenosis, intraluminal diaphragm or annular pancreas. Stomach and proximal duodenum enormously dilate. Manifestations include excessive vomiting, hypochloremic alkalosis, dehydration, weight loss, etc. Ileal, jejunal or even colonic atresia can also occur.

Meconium ileus is common. Here the distal ileum is obstructed by inspissated meconium causing obstruction. This may be complicated with volvulus, perforation, gangrene and meconium peritonitis.

Hirschprung's disease causes functional obstruction due to lack of ganglia in the distal colon and rectum. It is usually associated with vomiting, reluctance to feed, abdominal distension and failure to pass stool or meconium. Erect X-ray of abdomen shows multiple fluid levels indicating low

intestinal obstruction. Colostomy is done in neonatal stage followed by a “pull through” operation in later stage.

Anorectal anomalies may be high as in rectal agenesis where the rectum ends above the levator ani muscle. It may also be low as in *covered anus* where the rectum passes through the muscle to end close to perineum. High anomalies may be associated with rectourethral or rectovaginal fistula.

Anesthetic Care

- Special problems include hypovolemia, electrolyte and acid-base imbalance, abdominal distension, risk of vomiting and aspiration.
- Adequate fluid volume replacement, IV fluid therapy. Blood transfusion may be needed. Check electrolyte and acid-base status and correct, whenever needed. Stomach tube should be passed for decompression.
- Local anesthesia in very sick babies may be helpful.
- General anesthesia.
 - Atropine sulphate IV at the time of induction.
 - 100% O₂ by facemask.
 - Awake intubation.
 - Induction and maintenance of anesthesia with oxygen and halothane/isofurane. N₂O can cause further bowel distension.
 - Muscle relaxants for controlled ventilation.
 - Extubation when the baby is well awoken and in the lateral position.
 - In postoperative period, monitoring of vital signs is essential. Continue IV fluid therapy. Maintain intake output of fluids in a balanced way.

Necrotizing Enterocolitis

- It is common in lowbirth weight babies with history of birth asphyxia, respiratory distress syndrome and shock.

- *Characteristic manifestations:* Abdominal distension with ileus, blood in stools, typical X-ray appearance of gas in the bowel wall or even portal venous system. These are mostly due to intestinal injury secondary to ischemia of gut.

Dehydration, severe electrolyte imbalance, endotoxic shock, hypovolemia, sepsis, acidosis, coagulation disorders, etc. are the other features.

- Surgical intervention particularly when perforation and peritonitis occur.
- Anesthetic management:
 - Preoperative restoration of blood and fluid volumes.
 - Correction of coagulopathy.
 - Correction of acid-base and electrolyte imbalance.
 - Nasogastric suction.
 - Antibiotics.
 - Careful monitoring of vital signs.
 - *Problems:*
 - i. Prematurity, respiratory distress.
 - ii. Shock, sepsis, acidosis, coagulopathy.
 - iii. Antibiotic may interact muscle relaxants.
 - *Awake intubation:* Induction and maintenance of anesthesia with oxygen and isofurane. Avoid N₂O as this may distend intramural gas. Pancuronium can be used for relaxation.
 - *Postoperative period:* Continue IV fluid therapy. Monitoring of vital signs. Adequate nursing care.

Choanal Atresia

- Complete choanal atresia causes membranous or bony occlusion of posterior nares leading to severe respiratory distress. There is inability to pass a nasal catheter through the nostrils. Nasal obstruction must be relieved as early as possible initially by inserting an oral airway. The

airway should be kept in place by fastening with tapes to the cheeks of the baby until surgery is performed.

- Surgical procedure includes transnasal puncture and dilatation as an emergency and definitive repair later in childhood.
- *Anesthesia:*
 - IV atropine sulphate at the time of induction.
 - Awake orotracheal intubation. Induction and maintenance of anesthesia with $N_2O + O_2$ + halothane. Muscle relaxants may be needed for controlled ventilation.
- After nasal puncture a tube is usually passed through nose and kept for about 6 months.
- Extubation done while the baby is well awoken.

Bronchoscopy

- Emergency bronchoscopy may be needed to remove the foreign bodies.
- The patient should be kept immobile and fully relaxed to avoid the injury during bronchoscopy.
- A skilled anesthetist or a good assistant is helpful during the procedure.
- A small dose of thiopentone is given. Then bronchoscope is introduced. Oxygen is administered through the side channel or through vision hole of the bronchoscope with an endotracheal tube intermittently or a jet ventilation. Muscle relaxant can be used, if needed.
- Vital signs need monitoring during the procedure.
- Bronchoscope should be taken out gently with full vision afforded by laryngoscope.
- Patient should be watched carefully as laryngeal spasm, injury and edema can occur.
- Inhalational anesthesia with spontaneous ventilation is not much recommended.

Esophagoscopy

- It is usually indicated to remove the foreign body.
- There is chance of vomiting and aspiration as fluid/food may accumulate above the site of obstruction. All precautionary measures should be taken.
- General anesthesia with controlled ventilation should be given in the usual manner. Cuff of the endotracheal tube may need momentary deflation for the introduction of esophagoscope.
- Endotracheal tube should be extubated only after the return of gag and airway reflexes.

Congenital Lobar Emphysema

- It involves abnormal distension of a lobe usually left upper, right upper or right middle lobe. The emphysematous lobe compresses the adjoining normal lungs and cause mediastinal displacement. It may be associated with congenital heart lesion. The obstruction of bronchus supplying the emphysematous lobe may be due to extrinsic factors like abnormal blood vessels or intraluminal or due to defect of bronchial wall (bronchomalacia). The condition may cause serious respiratory distress in neonates and need extreme emergency surgical intervention. Chest X-ray shows a hyperlucent area and mediastinal shift.
- Surgery involves lobectomy, if no extrinsic or intraluminal causes are detected.
- Preoperative evaluation is most important. Respiratory inadequacy and cyanosis are common. Baby should be nursed at semiupright position. A nasogastric tube is needed for gastric suction. Oxygenation may be needed. IPPV is avoided due to possibility of "ball valve" effect.
- Bronchoscopy may be indicated to exclude intraluminal obstruction. It may be risky in presence of intrapleural

tension problems. It is usually done under general anesthesia using N_2O , O_2 and halothane with spontaneous ventilation.

- *Lobectomy:*

Orotracheal intubation: Induction and maintenance of anesthesia with N_2O , O_2 and halothane/isoflurane with spontaneous ventilation. Controlled ventilation is risky as it can cause more distension of emphysematous lobe and produce pneumothorax. N_2O can also cause more distension of the lobe and this should be avoided. When the chest is open, muscle relaxant can be used for controlled ventilation and N_2O can be used in the inspired gas mixture.

After lobectomy, the remaining lung tissue will gradually expand.

Adequate fluid therapy and replacement of blood are essential. At the end of operation, adequate decurarization is essential and extubation should be done when the baby is fully awoken.

- *Postoperative care:*

- Baby should be nursed in oxygen enriched atmosphere.
- Continue postoperative respiratory assistance.
- A chest drain (waterseal drainage) is needed.
- Chest X-ray to detect adequate expansion of lung tissue.
- Monitoring of vital signs is essential. In presence of generalized bronchomalacia, there is possibility of the other lobes to become emphysematous even in early postoperative period.

Myelomeningocele and Encephalocele

- These are due to failure of fusion of the neural tube in the fetus. The incidence of myelomeningocele is more

common in comparison to that of encephalocele. It may be associated with hydrocephalus.

- Excision of the sac and surgical repair of the defect should be done as early as possible afterbirth to prevent infection.
- *Anesthetic problems:*
 - Baby may be premature and with low body weight.
 - Positioning is difficult for intubation. Operation is usually done in prone position.
 - Blood loss is significant and blood transfusion is needed.
- *Anesthesia:*
 - The site of lesion should be covered with sterile dressings.
 - IV fluid infusion should be started. Blood should be kept ready. Blood loss should be measured.
 - The operation theater should be kept warm to minimize heat loss.
 - Atropine sulphate should be given IV before induction of anesthesia.
 - Awake intubation can be done while the baby is placed left side down with an assistant applying forward pressure at the back of the head and backward pressure on the shoulders to prevent extension of the neck.
 - Induction and maintenance of anesthesia should be done with N_2O , O_2 and halothane. Muscle relaxant can be used for controlled ventilation.
 - The baby is kept in prone position.
 - Muscle relaxant can be used. But it should be avoided if peripheral nerve stimulator is used to locate the nerve roots.
 - Baby should be nursed in warm incubator in postoperative period.

- Baby should be watched carefully particularly for signs of increased ICP particularly in cases of encephalocele.

Acute Abdomen

- Acute appendicitis, intussusception, perforated Meckel's diverticulum and intestinal obstruction are most common causes of "acute abdomen".
- Child should be evaluated preoperatively particularly the fluid, electrolyte and acid-base status.
- Child may have raised body temperature.
- These children should always be treated as "full stomach", and all precautions should be taken against aspiration of stomach contents.
- *Preoperative management:*
 - Adequate fluid replacement is vital. Urine output should be within normal limits.
 - Body temperature should be kept normal as far as practicable. Avoid atropine sulphate.
 - Gastric suction is always helpful.
- *Peroperative management:*
 - Continue IV infusion.
 - Continue monitoring the vital signs. Attach monitors.
 - Preoxygenation 100% O₂ for at least 4 min.
 - *Crash induction:* Thiopentone + suxamethonium IV injection. Cricoid pressure and endotracheal intubation.
 - Maintenance of anesthesia with N₂O + O₂ and nondepolarizing muscle relaxant.
 - At the end of operation, reverse the relaxants.
 - Extubation, when the child is well awoken.
 - Tonsillar position.
 - Adequate postoperative care and monitoring.

ANESTHETIC CARE FOR SOME SPECIFIC NONSURGICAL CASES

Respiratory Distress Syndrome (RDS)

- It is common in premature babies, asphyxia at birth, one of the twin babies, babies of maternal diabetes.
- It is mostly due to deficiency of lung surfactant, causing alveolar atelectasis, and reduction of lung compliance.
- *Manifestations:* Respiratory difficulty, increased respiratory rate, intercostal indrawing, use of the alae nasi, cyanosis, tachycardia, moist sounds on lung auscultation, X-ray chest shows opacity on lung fields.
- *Management:*
 - Controlled oxygen therapy. Beware of oxygen toxicity and retrolental fibroplasia.
 - IPPV
 - PEEP / CAP
 - Correction of fluid, and acid-base imbalance.

Tetanus Neonatorum

- The disease is caused by the toxin produced by anaerobic organism, *Clostridium tetani*. The portal of entry is the umbilical cord. The neurotoxin, tetanospasmin attacks the CNS after an incubation period of 7-10 days. The disease is fulminating in neonates.
- *Manifestations:* Spasm of jaw muscles, stiffness in the back and neck, facial spasm, respiratory muscle spasm, apnea.
- *Treatment:*
 - Immunotherapy
Human antitetanus immunoglobulin
Tetanus antitoxin

- Control of spasms
 - IV diazepam
 - Maintenance of respiratory function
 - Muscle relaxants IV and IPPV
 - Positive end-expiratory pressure (PEEP)
 - Tracheostomy
- Antibiotic therapy
- *General care:*
 - Avoid hypotension
 - Parenteral nutrition
 - Correction of acid-base imbalance
 - Avoid hyperthermia, fever
 - Maintain fluid balance
 - Adequate nursing care.

CHAPTER 7

Anesthesia for Obstetric Emergency

PHYSIOLOGICAL CHANGES IN PREGNANCY

Respiratory System

- Capillary engorgement and edema of the nasopharynx, larynx, trachea and bronchi. Instrumentation like laryngoscopy and nasal intubation can cause further edema and obstruction. Mothers with pre-eclampsia or eclampsia are mostly vulnerable.
- Lung volumes do not change much until the fifth month of gestation, but thereafter there is progressive decrease in expiratory reserve volume, residual volume and functional residual capacity. These changes are more obvious in supine position, obesity and mitral valve disease.
- Vital capacity is unchanged in normal mother at term and total lung capacity is decreased slightly due to elevation of diaphragm. Functional residual capacity is also reduced.
- At term, minute ventilation is increased as respiratory rate increases and tidal volume increases. Dead space remains normal.
- Hyperventilation can cause respiratory alkalosis and compensating metabolic acidosis.
- At term basal metabolic rate increases along with oxygen consumption. Increased O_2 consumption and reduced functional capacity increase the risk of maternal hypoxia.

Cardiovascular System

- Blood volume increases. Expansion of plasma volume is more in relation to red cell mass. This causes physiologic anemia in pregnancy.
- Cardiac output increases proportionately in pregnancy. It may fall in supine position in last few weeks of pregnancy due to aortocaval compression.

- Arterial blood pressure decreases due to decrease in peripheral resistance. Diastolic pressure decreases more than the systolic, pulse pressure is increased.
- Venous blood pressure is mostly normal. But it may increase as pregnancy continues due to venous obstruction caused by pressure of enlarged uterus on inferior vena cava and pelvic veins.

Acid-base Changes

- Total base decreases. There is decrease of plasma sodium, potassium, calcium and magnesium.
- Plasma bicarbonate decreases.
- PaCO_2 decreases. PaO_2 increases.
- Plasma buffer base decreases.
- pH remains more or less normal, but in some cases mild metabolic acidosis can occur.

Gastrointestinal System

- Decrease of gastric and intestinal motility.
- Delay in gastric emptying time.
- Cardiosophageal sphincter tends to dilate making the mother prone to gastroesophageal reflux.

Renal System

- Gradual dilation of renal pelvis, calyces and ureters, increase in glomerular filtration rate. Rate of urine formation is more.

Endocrine System

- Estrogen, progesterone and chorionic gonadotropin are produced by corpus luteum and placenta.
- Hyperplasia of thyroid and parathyroid glands.
- Hypertrophy of pituitary gland and adrenals.

Metabolism

- i. Basal metabolic rate increases.
- ii. O_2 consumption increases.
- iii. Retention of water, protein and electrolytes.

PAIN DURING LABOR AND DELIVERY

It includes two components: Visceral and sensory pain.

- Visceral pain is due to dilation and effacement of the cervix during uterine contraction. Uterine ischemia may also be a factor. It is referred to the lower abdomen and lower back. Afferent pain sensations from the cervix and uterus are carried by nerves that accompany sympathetic nervous system fibres and enter the spinal cord T_{10} - L_1 .
- Somatic pain is due to stretching of vagina and perineum during descent of the fetus. Pain pathways from the perineum pass to S_2 - S_4 through the pudendal nerve.

Visceral pain dominates the first stage of labor and somatic pain in the second stage. However, these overlap significantly.

Pain Relief for Labor and Delivery

Criteria

- Produce satisfactory pain relief.
- No disturbance with the progress of labor.
- Safe to the mother and fetus.
- Provides satisfactory and safe conditions for delivery.
- Early interaction between mother and baby.

Nonpharmacological Methods of Pain Relief

- Acupuncture.
- Hypnosis.
- Prenatal education, breathing and relaxation exercises, sympathetic attitude for medical and paramedical personnels, relatives encouragement.

Pharmacological Approach

- *Opioids*: Usually indicated in first stage of labor. Pethidine, butorphanol, fentanyl are being used in small doses. Patient controlled intravenous analgesia is mostly popular nowadays.
- Ketamine in small IV doses (0.25 mg/kg) can be used satisfactorily without any risk or adverse reactions. Large doses can cause unconsciousness, increased uterine tone in the mother and respiratory depression and muscle rigidity to newborn.
- Midazolam.
- *Inhalational analgesia*:
 - Subanesthetic concentration of anesthetics. Entonox is mostly popular. It provides rapid onset of analgesia, maintenance of airway reflexes and no undue depression of respiration to mother and baby.
 - *General anesthesia*
Not much indicated for pain relief for labor and delivery.
- *Regional anesthesia*:
 - Continuous lumbar epidural analgesia.
 - Paracervical block : for perineal anesthesia.
 - Caudal analgesia (not much used).
 - Spinal analgesia.
 - Pudendal nerve block (bilateral).

ANESTHESIA FOR CESAREAN SECTION**Indications*****Real/immediate Cesarean Section***

- Severe fetal distress.
- Profuse uterine bleeding.
- Prolapsed umbilical cord.
- Rupture of uterus

Urgent Cesarean Section

- Pre-eclampsia/eclampsia.
- Malpresentation of fetus.
- Cephalopelvic disproportion
- Mild fetal distress
- Unsatisfactory progress of labor
- Failed trial of labor
- Previous cesarean section
- Failed forceps delivery

Preanesthetic Check-up

- Check the maternal condition carefully.
- IV infusion of fluids, blood transfusion may be needed. Optimize the volume status as far as practicable.
- Maintain left uterine displacement for prevention of aortocaval compression.
- Monitoring of vital signs, CVP, pulse oximetry, ECG, coagulation status, etc. is essential. Correct coagulopathy, if present.
- Check the fetal heart sounds.

Note: For real/immediate cesarean section, general anesthesia is the most recommended anesthetic technique.

Procedures for General and Regional Anesthesias***General Anesthesia***

- Preoperative preparation and premedication. Pharmacologic attempt to increase the gastric pH. Oral sodium citrate, ranitidine, ondansetron IV. Anxiolytic drugs (diazepam).
- Patient placed on operation theater table with slight head up tilt and pelvis tilted to left by a pillow under the right hip.
- Blood pressure, pulse oximetry and ECG monitored.
- Preoxygenation for 5 minutes.

- Precurarization with small dose of tubocurarine.
- Rapid induction of anesthesia with thiopentone and succinylcholine.
- Cricoid pressure applied (Sellick's maneuver).
- Intubation with a cuffed endotracheal tube.
- Anesthesia maintained with only N_2O and O_2 until delivery of the baby.
- After delivery, low dose of volatile anesthetic (halothane 0.5%) can be given. Relaxants may be given for IPPV. Opioid can also be given.
- Care should be taken against aspiration at the end of anesthesia and during intubation.
- Extubation should be done after reversal of neuromuscular block and when the mother gains consciousness and adequate spontaneous respiration returns.

Regional Anesthesia

Spinal Anesthesia

The technique is easy. A T_4 - T_6 sensory level is needed. Hypotension should be carefully treated. Blood pressure needs monitoring all the while. Success rate is satisfactory. *Advantages:* Simple procedure, speedy onset, reliable, minimum fetal drug exposure, minimum risk of aspiration. Mother remains awake.

Disadvantages: Risk of hypotension, nausea and vomiting, postspinal headache.

Lumbar Epidural Analgesia

Concentration of bupivacaine should be kept at 0.5%.

Advantages

Avoidance of dural puncture, no postoperative headache, decreased incidence of hypotension. Complete pain relief for mother and excellent condition for obstetrician.

Disadvantages

Time consuming, fetal drug exposure significant, possibility of total spinal anesthesia, problems of inadequate analgesia.

Note: Conduction anesthesia is not much recommended for a real emergency cesarean section. Both spinal and epidural block can cause hypotension and further decrease of blood flow to fetus. It may be dangerous in presence of fetal distress.

Mendelson's Syndrome

It is the result of aspiration of liquid gastric juice with a pH of 2.5 or less causing clinical manifestations of pulmonary edema, pulmonary vasoconstriction and pulmonary hypertension. Tachycardia, hypotension, tachypnea, wheezing, blood stained frothy mucus are also common. There are decreased pulmonary compliance, inequality of ventilation perfusion ratio and significant intrapulmonary shunting and X-ray evidence of irregular soft mottling in peripheral lung fields.

Immediate management of aspiration includes:

- Suction of mouth and pharynx. Administer 100% oxygen before and after suctioning subsequently.
- Bronchial irrigation only in cases of obstruction type of aspiration.
- Nasogastric suction.
- Oxygenation.
- *Mechanical ventilation:* Intubation and IPPV with PEEP is indicated when the patient shows dyspnea, cyanosis, tachypnea, tachycardia, airway obstruction (tracheal tug, retraction) flaring, the use of accessory muscles of respiration, decreased PaO_2 , increased PaCO_2 , arterial pH less than 7.2, decreased vital capacity and effective compliance. In such cases IPPV can relieve the patient's exhaustion and dyspnea, improve alveolar ventilation

and reduce shunting. It is also helpful to reduce the pulmonary edema.

- Bronchodilators, antibiotics, supportive care.

Failed Intubation Drill

Endotracheal intubation in a pregnant patient may be difficult. One should follow a routine in facing such problem.

- Maintain cricoid pressure carefully. A trained assistant is always helpful.
- Patient should be placed head down in the left lateral position.
- Oxygenation with 100% oxygen continued. IPPV, if the effect of suxamethonium persists.
- Patient may be allowed to recover and call for expert help.
- *Further alternative measures:*
 - Reattempt general anesthesia.
 - Spinal anesthesia.
 - Epidural anesthesia if a catheter is already *in situ*.
 - Inhalational anesthesia.
- For cases of parturient with profuse hemorrhage, shock and fetal distress where surgery is needed as urgently as possible, it is better to adopt the following:
 - Maintain cricoid pressure.
 - Patient kept head down.
 - Maintain oxygenation and anesthesia with 40% oxygen, 60% nitrous oxide and a volatile anesthetic agent like halothane/enflurane/isoflurane.

ANESTHESIA FOR LABOR AND DELIVERY IN MILD/SEVERE PRE-ECLAMPSIA

Regional Anesthesia

Regional anesthesia particularly continuous epidural anesthesia is mostly recommended in such cases. But it should be properly administered under good medical control to minimize the associated complications.

Advantages

- It helps to control blood pressure.
- It helps to increase renal and uterine perfusion by preventing endogenous catecholamine secretion associated with anxiety and pain.
- It controls pain.

Disadvantages

Sudden hypotension during epidural block can decrease uterine blood flow and cause fetal asphyxia.

Note:***Hypertension in pregnancy:***

- Pre-eclampsia, eclampsia.
- Chronic hypertension.
- Chronic hypertension with added pre-eclampsia or eclampsia.
- Gestational hypertension.

Toxemia Pregnancy

- It specifically denotes pre-eclampsia and eclampsia.
- Pre-eclampsia refers to a syndrome of hypertension, proteinuria and generalized edema manifesting after 20th week of pregnancy.
- Eclampsia manifests grand malconvulsions superimposed on pre-eclampsia.
- A blood pressure above 140/90 mm Hg or a rise of systolic pressure of 30 mm Hg above normal or a diastolic pressure of 15 mm Hg above normal with urinary protein loss over 2 gm a day can be regarded as the signs of pre-eclampsia.

Other features include:

- Hyper-reflexia and increased CNS irritability.
- Increased blood uric acid level.
- Edema of larynx and upper airway.

- Coagulation disorders (HELLP syndrome: Hemolysis, elevated liver enzymes, low platelet count).
- Hyperactive uterus.
- Premature labor.
- Pulmonary edema.
- Congestive heart failure.
- Maternal asphyxia.
- Cerebral edema, coma.

Causes of Maternal Death

- Pulmonary edema.
- Congestive heart failure.
- Cerebral encephalopathy.
- Placental abruption.
- Renal failure.
- Pituitary necrosis.
- DIC.

Special Problems of Neonate from a Toxemic Mother

- Prematurity.
- Small for gestational age.
- Neonatal asphyxia.
- Meconium aspiration.
- Drug depression.

Management of Pre-eclampsia/Eclampsia

- Complete bed rest. Better to be hospitalized.
- Judicious fluid therapy.
- Salt restricted diet.
- Antihypertensive drugs, diuretics (furosemide).
- Sedative (diazepam), anticonvulsive drugs.
- Magnesium sulphate.
- Definitive treatment : Delivery of fetus and placenta.

Management of General Anesthesia

General anesthesia may have to be given in selected cases particularly when regional anesthesia is either contra-indicated or extremely risky.

- Before general anesthesia the progression of pre-eclampsia should be controlled and the fetus must be protected as far as practicable.
 - Circulating fluid volume needs expansion cautiously.
 - Magnesium sulphate.
 - Antihypertensive drugs.
 - i. Labetolol IV.
 - ii. Hydralazine IV.
 - iii. Sodium nitropruside IV.
 - Furosemide in selected cases of oliguria.
 - If convulsion occurs, oxygenation, anticonvulsant drugs (diazepam, midazolam, magnesium sulphate).
 - Left uterine displacement.
 - An IV line should be established.
- Induction of anesthesia with thiopentone (3 to 5 mg/kg) and succinylcholine (1 to 1.5 mg/kg) IV followed by rapid intubation of trachea. Sellick's maneuver is extremely needed.

Caution

- Edema of upper airway may cause difficulty in intubation.
- Magnesium sulphate therapy may attenuate skeletal muscle fasciculations following succinylcholine injection.
- Pressor response by direct laryngoscopy may occur. Hydralazine 5 to 10 mg IV prior intubation is helpful.
- Maintenance of anesthesia can be done with N_2O , oxygen and volatile anesthetic. This helps to control intra-operative hypertension. Magnesium therapy may

potentiate the effects of both nondepolarizing and depolarizing muscle relaxants.

- Delivery of fetus and placenta can terminate the effects of pre-eclampsia but complete recovery may take hours to days and even the mother is at risk for seizures.
- Careful monitoring of vital signs is essential in postoperative period. Magnesium sulphate therapy should be continued for at least 24 hours after delivery.

Hemorrhage in Early Pregnancy

Bleeding per vagina in early pregnancy is mostly due to abortion, ectopic pregnancy and hydatidiform mole. Some of them need urgent surgical intervention and require skilled anesthetic management.

Abortion

It is the termination of pregnancy before the period of viability at 20th week of pregnancy or the fetus weighing less than 500 gm.

Inevitable Abortion

Abortion is progressed to a state from where continuation of pregnancy is impossible.

Incomplete Abortion

The entire products of conception are not expelled and a part of it is left in the uterine cavity. It may lead to profuse bleeding, sepsis, etc.

Septic Abortion

It is associated with infection in the uterine cavity and its contents. Manifestations include pyrexia, pain abdomen, peritonitis, endotoxic shock, jaundice, acute renal failure and so on.

Management

- *General measures:*
 - IV fluid therapy, correction of shock, blood transfusion, antibiotics
 - Morphine sulphate
 - Ergometrine, if cervix is dilated and uterine size is less than 12 weeks.
- *Active treatment:*
 - Dilatation and evacuation followed by curettage under general anesthesia as early as possible.
 - Suction evacuation followed by curettage
 - After 12 weeks of gestation :
 - i. Oxytocin drip
 - ii. If placenta is not separated, evacuation of uterus by abdominal hysterotomy under general anesthesia.

Anesthetic Implications

- For evacuation of uterus, general anesthesia is usually given, volatile anesthetics those are uterine relaxants should be avoided. An IV induction with thiopentone and suxamethonium and maintenance with N_2O , O_2 and small doses of analgesics and nondepolarizing muscle relaxants is mostly satisfactory. Ergometrine is mostly needed during the procedures.
- Termination of advanced stages of pregnancy may need abdominal hysterotomy. Epidural anesthesia may be helpful in such cases. Standard technique of general anesthesia is used for cesarean section can also be chosen.
- The problem of placental transfer of drugs does not arise in such cases of termination of pregnancy.

Ectopic Pregnancy

Here the fertilized ovum is implanted and developed outside the uterine cavity commonly in fallopian tube. Early

interruption is inevitable within 6 to 8 weeks. It may terminate as tubal rupture or tubal abortion with massive intraperitoneal hemorrhage and shock.

Management

- The patient needs early diagnosis and resuscitation. It is better to hospitalize the patient immediately.
- Adequate resuscitation with
 - Complete bed rest, supine on bed.
 - IV infusion of fluids. Blood transfusion.
 - Vasopressors.
- Laparotomy under general anesthesia with the principle *quick in and quick out*. A quick subtotal hysterectomy may be needed in some extreme cases.
- *Anesthetic implications:*
 - General anesthesia is preferred. Rapid induction with IV thiopentone and succinylcholine, cricoid pressure, rapid endotracheal intubation. Maintenance of anesthesia with N_2O , O_2 and intermittent doses of pethidine and nondepolarizing muscle relaxants, IPPV. Avoid all drugs those cause vasodilation. Take all precautions against vomiting and aspiration.
 - Maintain blood pressure and pulse rate and fluid balance.
 - Monitoring of vital signs is essential.
 - Regional anesthesia is not recommended in such critical condition.

Antepartum Hemorrhage

Major Causes

- *Placental causes:* Placenta previa, abruption placenta.
- *Cervical causes:* Polyp, carcinoma.
- Vaginal/vulvar varicosities.
- Uterine rupture.

- Other causes: Pre-eclampsia, intrauterine death, pre-existing coagulation disorders.

Placenta Pervia

Here the placenta implants on the lower uterine segment. It may be complete, partial or marginal depending on the amount of cervical os covered by the placenta.

Probable predisposing factors include multiparity, elderly mothers, previous cesarean section, large placenta and so on.

Clinical Manifestations

- Painless bleeding per vagina.
- Blood, bright red clots.
- Bleeding is obvious, not concealed.
- Diagnosis confirmed by ultrasonography.

Vaginal examination should be performed only with the immediate capability of converting of cesarean section.

Management

- Mostly depends on the degree of blood loss, shock, the type of placenta previa and the gestational age of fetus.
- If there is stoppage of bleeding, patient's condition is more or less stable, fetal condition is satisfactory, conservative treatment is attempted. Complete bed rest. Monitoring of fetal condition is essential.
- In presence of continued bleeding and signs of fetal distress, emergency cesarean section is indicated. General anesthesia is mostly preferred. Conduction anesthesia in presence of hypovolemia and maternal hemodynamic instability may be dangerous.

General Anesthesia

- Adequate resuscitation IV fluid therapy. Blood transfusion.
- Precautions against aspiration and vomiting nonparticulate antacid by mouth. Ondansetron, metoclopramide.

- Denitrogenation of lungs by 100% oxygenation for 5 minutes.
- Rapid sequence induction with ketamine and suxamethonium, cricoid pressure, rapid orotracheal intubation. Maintain anesthesia with N_2O , O_2 and isoflurane. Constant monitoring of vital signs is essential.
- Risk of massive hemorrhage is present until the placenta is removed and the uterus contracts.
- Baby may suffer from asphyxia, acidosis and hypovolemia and need immediate intensive care.

Abruptio Placenta

It denotes premature separation of the placenta from the uterus before the delivery of fetus. Possible predisposing factors include hypertension, pre-eclampsia, multiparity, coagulopathy, etc.

Clinical Manifestations

- Pain lower abdomen
- Port-wine blood per vagina
- Blood does not clot, profuse bleeding
- Bleeding mostly concealed.
- Hypovolemia, shock
- Disseminated intravascular coagulation (DIC) is common, Renal failure can occur.
- Diagnosis is confirmed by ultrasonography.

Management

- Resuscitation of the mother.
- Delivery of the fetus.
- Vaginal delivery may be tried if the fetal condition is satisfactory (no fetal distress) or if the fetus is dead.
- Cesarean section, if there is fetal distress or the maternal condition is deteriorating.

- *Anesthetic implication:*

- Profuse hemorrhage, shock, hemodynamically unstable mother contraindicates regional anesthesia. Presence of coagulation disorders is also a contraindication.
- General anesthesia may be preferred technique provided the volume replacement is adequate and adequate precautionary measures against vomiting and aspiration are taken.

Uterine Rupture

- It is a very serious condition with a high mortality rate. Rupture usually occurs at the site of old scar caused by previous cesarean section or myomectomy. Nonscarred uterus can also rupture due to prolonged turbulent labor and it is always associated with high maternal and fetal mortality. Other predisposing conditions include rapid spontaneous delivery, excessive uterine stimulation, cephalopelvic disproportion, multiple parity, polyhydramnios, etc.
- Clinical features include severe pain abdomen, profuse bleeding, shock and fetal distress. An old scar rupture may sometimes be asymptomatic.
- Uterine rupture can occur antepartum, intrapartum or postpartum.

Management

- Rapid diagnosis is essential.
- Immediate delivery and repair of uterus.
- *Anesthetic considerations:*
 - If the degree of hemorrhage is not much and maternal intravascular volume is satisfactory, epidural anesthesia may be chosen.
 - If blood loss is significant, then general anesthesia with rapid sequence induction, cricoid pressure, endotracheal intubation and IPPV, maintenance with

N_2O and O_2 and low doses of isoflurane may be helpful. Take all precautionary measures against vomiting and aspiration.

Postpartum Hemorrhage

- It is the bleeding from or into the genital tract following birth of the baby upto the end of puerperium. It may be either primary or secondary. Primary type indicates hemorrhage per vagina within 24 hours following the expulsion of placenta. When hemorrhage occurs beyond 24 hours upto the end of puerperium, it is delayed, late or secondary puerperal hemorrhage.
- It may be due to uterine atony, disruption of genital tract, placental abnormalities, coagulation disorders, pre-eclampsia, retained products of conception, placenta accreta, etc.
- Immediate treatment is most vital. Pharmacological treatment includes oxytocics, methyl ergometrine and prostaglandins.

Management

- The exact cause of hemorrhage should be diagnosed and treated accordingly.
- IV fluid therapy. Blood transfusion may be needed.
- *Bleeding from placental site:*
 - Massage the uterus, bimanual compression, sedation.
 - Ergometrine
 - Manual removal of placenta
 - Hysterectomy in extreme cases
 - Laparotomy and hypogastric artery ligation in selected cases.

Retained Placenta

When the placenta is not expelled out within 30 minutes after the birth of the baby, it is said to be retained placenta. It may be due to adherant placenta (partial or incomplete), retention

of nonseparated placenta due to atonic uterus or when placenta completely separated but retained due to low expulsive efforts.

It can cause severe hemorrhage, blood loss, shock, puerperal sepsis, etc.

Management

- Vascular resuscitation, IV fluid therapy, blood transfusion.
- Note the signs of separation of placenta.
- *Take the necessary steps:*
 - Controlled cord traction
 - Manual removal of placenta under general anesthesia.
 - Hysterectomy in extreme cases.

Anesthetic Implications

- Assess the patient carefully. She may be anemic with poor perfusion and shock.
- IV fluid therapy, blood transfusion, plasma volume expanders, vasopressors.
- Adequate monitoring of vital signs, CVP, pulse oximetry.
- Sedatives
- Regional anesthesia only in hemodynamically stable patient.
 - Epidural/caudal/spinal block.
 - Combined pudendal and paracervical block may be helpful to make lower birth canal and the uterus insensitive.
- General anesthesia is mostly satisfactory, rapid sequence induction technique is employed, using thiopentone, suxamethonium, cricoid pressure, followed by rapid endotracheal intubation; maintenance with N_2O , O_2 and halothane. However, uterine relaxation should be avoided.
- Take all measures against Mendelson's syndrome. The emetic and pressor effects of IV ergometrine should be borne in mind.

Acute Inversion of Uterus

Here the uterus is turned inside out partially or completely. It is mostly serious and occurs due to mismanagement of the third stage of labor.

Causes

- Cord traction or fundal pressure when the uterus is relaxed and the placental site is at fundus.
- Faulty manual removal of placenta.

Manifestations

Severe pain, hemorrhage, severe shock. Bleeding is exaggerated due to restriction of venous outflow from the inverted uterus. Neurogenic shock due to traction on the sympathetic nerves.

Management

- Resuscitation, infusion of fluid, blood, plasma volume expanders.
- Urgent reduction of inversion. Replacement of uterus either manually or by hydrostatic method.
- General anesthesia is always helpful. Muscle relaxants should be used. Avoid uterine relaxation.
- Laparotomy may be needed in extreme cases.

CHAPTER 8

Anesthesia for Abdominal Emergency

INTRODUCTION

Emergency anesthesia for acute abdominal conditions may sometimes be problematic and it may need skilled anesthetic care. Early identification and initial management of such emergencies are most vital for safe anesthesia to these cases. Common physiologic and anatomic understanding are also essential for better patient care.

Essential Criteria for Good Anesthesia

- Profound relaxation of abdominal muscles and peritonium.
- Quiet smooth breathing when volatile anesthetics are used with spontaneous or assisted breathing. But most abdominal operations are done with intermittent positive-pressure ventilation (IPPV) with the use of muscle relaxants.
- Airway should always be protected from aspiration of gastric contents.
- No undue circulatory depression. Protection against shock.
- Safe, no toxic, allergic or untoward reactions.
- Minimal interference to metabolic response to injury.
- Smooth pleasant induction.
- Minimal postanesthetic complications.
- Early uneventful recovery.
- Completely safe.

VARIOUS METHODS OF ANESTHESIA

- General anesthesia.
- Regional anesthesia
 - Field block
 - Spinal anesthesia
 - Epidural anesthesia
- Light general anesthesia along with regional block.

General Anesthesia

- Preoxygenation.
- Anesthesia is induced with IV thiopentone and suxamethonium in usual doses.
- Laryngoscopy and endotracheal intubation. A cuffed endotracheal tube should be used.
- Intermittent positive pressure ventilation (IPPV)
- Maintenance of anesthesia with nitrous oxide, oxygen and intermittent doses of nondepolarizing muscle relaxant and analgesics like pethedine.
- *Controlled ventilation*: Volatile anesthetic agents like halothane, enflurane or isoflurane can be used, whenever needed. Anesthesia should be deep and it should produce satisfactory muscle relaxation for abdominal operations. Semiclosed or closed circuit or Bain circuit can be used satisfactorily.
- At the end of anesthesia adequate decurarization with IV atropine and neostigmine is mandatory. Extubation should be done when the patient is well awoken and without any respiratory depression.
- Monitoring during anesthesia is essential, vital signs, pulse oximetry, ECG etc. should be monitored.

Regional Anesthesia

It may be a good alternative to general anesthesia particularly when it is contraindicated. It can give good results with profound muscular relaxation, if done properly. But the main disadvantages include:

- Time-consuming technique
- Risk of hypotension
- Toxicity of local anesthetics
- Not suitable for noncooperative patients, children.

Epidural anesthesia provides good muscular relaxation, complete analgesia, contracted bowels and minimum postoperative complications. Hypotension, if it occurs

should be treated with IV fluids and vasopressors. An extradural catheter is helpful for serial injections of local anesthetic in case of prolonged operation and to provide postoperative analgesia.

Spinal anesthesia is not much popular, but can be used for abdominal operations. It also provides profound muscular relaxation. For lower abdominal operations upto T₉ or T₈ and for upper abdomen upto T₅ or T₄ block is necessary.

Preanesthetic Assessment

Patient needs careful clinical examination.

- *Pain*: Visceral, parietal or referred pain, character of pain, location of pain, onset of pain, severity, aggravating or alleviating factor, if any.
- *Associated symptoms*: Diarrhea, fever.
- *Gynecological/menstrual history*.
- *Other medical history*: Hypertension, diabetes, heart failure, asthma, chronic obstructive pulmonary disease (COPD), etc.
- *A medication history*: Digitalis, antihypertensives, steroids, etc.
- *Physical examination*: A thorough examination of abdomen including cardiovascular and respiratory system should be done.
- *Laboratory studies*:
 - Complete blood count.
 - Electrolytes, urea nitrogen, creatinine.
 - *Liver function tests*: Transaminase, alkaline phosphatase, coagulation studies, amylase/lipase.
 - Urine analysis
 - Pregnancy test, whenever needed.
 - Chest X-ray, abdominal X-ray.
 - Electrocardiogram (ECG)
 - Computed tomography (CT), Ultrasound, etc. in selected cases.

Preanesthetic Preparation

- The acute patients should be approached aggressively and without delay.
Establish a patent airway, adequate ventilation. Adequate vascular access and circulation. Fluid and electrolyte imbalance should be corrected.
- The problem of regurgitation and vomiting is always there. Take all precautionary measures against aspiration of gastric contents.
- Coexisting diseases like hypertension, diabetes, asthma, etc., if present should be attended to.
- Intercurrent medical therapy, if any also needs careful attention.
- Infection, if present should be treated with suitable antibiotics.

ANESTHESIA FOR PERFORATED BOWEL AND PERITONITIS

Problems

Patient is usually toxic, hypovolemic and dehydrated. Full stomach always exists. Electrolyte disturbances and metabolic acidosis are common in such cases.

Preoperative Assessment

- The severity of the shock, fluid deficit and toxemia should be assessed.
- Laboratory investigations should include complete blood count, packed cell volume (PCV), serum electrolytes, urea, nonprotein nitrogen (NPN), sugar, blood gas study. Urine analysis.
- Determine urine output.

Preparation

- Intravenous fluid therapy. Blood transfusion may be needed. Adequate resuscitation is essential.
- A nasogastric tube should be passed for gastric suction.
- No premedication is usually needed.

Anesthesia

- Preoxygenation.
- Crash induction. IV thiopentone and suxamethonium, cricoid pressure, intubation with cuffed endotracheal tube. Inflate cuff immediately after intubation.
- Maintenance of anesthesia with N_2O , O_2 , and intermittent doses of nondepolarizing muscle relaxants like vecuronium or atracurium. Intermittent positive-pressure ventilation (IPPV) is needed. Small doses of halothane can be given, if not otherwise contraindicated.
- Monitoring of pulse, blood pressure, central venous pressure (CVP), ECG and urine output is essential.
- At the end of operation reversal of relaxant is necessary. Extubation should be done when the patient is well awoken and there is no respiratory depression. Stomach should be evacuated before extubation.

Postoperative Care

- Analgesia
- Continue IV fluid therapy
- Continue monitoring
- Adequate nursing care.

Acute Abdomen

It is manifested by pain originating from the peritoneum, hollow intestinal viscera, mesentery or pelvic organs. Extraperitoneal causes of acute abdomen may also be due to intrathoracic, neurogenic, metabolic and vascular causes.

Common Causes of Pain Abdomen

- *Gastrointestinal*: Peptic ulcer disease, Meckel's diverticulitis, small intestinal obstruction, appendicitis, large bowel obstruction, perforated viscus, etc.
- *Hepatobiliary*: Cholecystitis, cholangitis, hepatic abscess, acute pancreatitis.
- *Splenic*: Splenic infarct
- *Urological*: Urinary tract infection, acute pyelonephritis, renal infarct, renal stone.
- *Gynecological*: Ovarial torsion, ectopic pregnancy, tubo-ovarian abscess, ovarian cyst.
- *Vascular*: Aortic aneurysm, acute mesenteric ischemia, aortic dissection, mesenteric venous thrombosis.

ANESTHESIA FOR ACUTE INTESTINAL OBSTRUCTION**Causes of Mechanical Intestinal Obstruction**

- Adhesions.
- Hernia.
- Intestinal tumor.

Obstruction interferes the normal progression of bowel contents due to some actual barrier that blocks the lumen. Ileus is the failure of downward movement of contents due to impaired propulsion.

Small intestine mechanical obstruction with intact vascularity causes accumulation of fluid and gas and impairment of motility. In cases of bowel distension by gas, blood supply may be hampered to cause ischemia. Large bowel obstruction usually does not strangulate except in case of volvulus. Here progressive distension occurs and it may be dangerous, if not relieved in time.

A distended bowel for a long period of time may cause decreased blood supply and ischemia of the gut and strangulated obstruction can also occur. The accumulation

of fluid and gas in the obstructed bowel, impaired motility, extravasation of blood and fluid into the bowel and toxic substances and its breakdown products in the gangrenous bowel, etc. make the condition grave.

Strangulated obstruction needs emergency surgical intervention to prevent progression to frank bowel necrosis.

Volvulus

A segment of intestine twists around its mesentery.

Problems

- Presence of severe fluid loss, hypotension.
- Prone to vomiting, regurgitation and aspiration of gastric contents.
- Distension of abdomen, cardiorespiratory embarrassment, hypotension.
- Dehydration.
- Electrolyte imbalance, acid-base imbalance.

Note: Vomiting can cause loss of chlorides, alkalosis, fluid loss and dehydration.

Low intestinal obstruction causes much distension.

High intestinal obstruction: vomiting is much prominent.

Complete colonic obstruction requires urgent surgery.

Laboratory Findings

- Hemoconcentration
- Decreased fixed base in serum
- Loss of plasma chlorides
- Blood urea, NPN increased.
- *Urine:* Acidic, low chloride, ketone bodies may be present.

Preoperative Assessment and Preparation

- Patient needs careful history and clinical examination.
- Laboratory studies should be reviewed.

- A large nasogastric tube should be passed and gastric suction should be made as much as possible. The tube should be removed to allow effective cricoid pressure during induction.
- Adequate resuscitation, IV fluid therapy.
- Blood transfusion may be needed.
- Patient should be assumed as 'full stomach' and all precautions should be taken against aspiration.
- Presence of peritonitis indicates the need for emergency surgical intervention.

Anesthesia

- *Premedication:* Avoid drugs causing respiratory depression. Atropine can be given to protect the heart from potent vagal stimulation caused by the use of vagomimetic drugs and tracheal intubation. But it should be avoided in presence of tachycardia and hyperpyrexia.
- *A rapid sequence induction technique:*
 Preoxygenation
 Precurarization
 IV thiopentone and suxamethonium
 Cricoid pressure and rapid intubation with a cuffed tube, cuff inflated immediately after intubation.
- *Maintenance of anesthesia:*
 IPPV with nitrous oxide and oxygen and intermittent doses of muscle relaxants; volatile anesthetics like halothane or isoflurane can be used.
- At the end of operation, residual muscle relaxant should always be reversed with neostigmine and atropine. Extubation is done after return of airway reflexes.
Monitoring of vital signs: CVP, blood pressure, ECG, serum electrolytes, blood gas study.

Postoperative Care

- Continue monitoring
- Respiratory assistance may have to be continued.
- IV fluid and electrolytes. Fluid balance chart should be maintained.
- Antibiotics nutritional care.

Bleeding Esophageal Varices

- It is mostly due to obstruction to the flow of blood in the hepatic portal veins. The obstruction is mostly caused by cirrhosis of liver. As the blood flow is partially blocked, it passes through alternate routes of low pressure. In the gastrointestinal tract, there are some areas where portal venous drainage and the systemic venous drainage have common territory. These include esophageal veins, hemorrhoidal veins and paraumbilical veins. Common causes of upper gastrointestinal bleeding include duodenal ulcer, varices, gastritis, gastric ulcer, esophagitis, bowel infarction and so on.

Surgical Management:

- Endoscopic injection under local anesthesia.
- Transection or stapling of the lower esophagus under general anesthesia.
- Portosystemic anastomosis under general anesthesia.
- *Problems:*
 - Patient is anemic, tachycardiac, hypotensive, dyspneic and perhaps in shock.
 - Significant reduction of blood volume.
 - Presence of hypoproteinemia.
 - Patient is suffering from cirrhosis liver with gross hepatic dysfunction.
 - Coagulation problems.

- *Preanesthetic evaluation and preparation:*
 - Careful clinical examination.
 - *Laboratory studies:*
 - Blood exam, blood biochemistry, urea, NPN, sugar
 - serum electrolytes
 - Liver function tests
 - Coagulation studies
 - ECG.
 - IV fluid therapy. Fresh blood transfusion may be helpful.
 - Adequate vascular resuscitation
 - Gastric lavage with chilled saline may be helpful to slow or stop bleeding.
 - Take all precautionary measures against vomiting and aspiration of gastric contents.
 - Esophageal balloon may be attempted to stop bleeding. But it may be associated with malplacement, incorrect inflation or displacement of balloon afterwards. Usual complications include aspiration, asphyxia, rupture of esophagus, ulceration at the site of tamponade.
 - Usually no premedication is needed if the patient is comatose. Only atropine may be given. Minimum doses of sedative/analgesic may be given.
- *Anesthesia:*
 - Avoid hepatotoxic drugs.
 - Induction with sleep doses of thiopentone and suxamethonium. Rapid sequence induction with cricoid pressure. Use cuffed endotracheal tube.
 - Patient with cirrhosis of liver may have low serum pseudocholinesterase and thus can prolong the effect of suxamethonium.
 - Maintenance of anesthesia with nitrous oxide, oxygen and muscle relaxants like atracurium, vecuronium.

Intermittent positive-pressure ventilation (IPPV). Isoflurane can also be used.

- Intravenous fluid therapy. Fresh blood should be readily available.
- Monitoring of vital signs, pulse oximetry, ECG, CVP and serum electrolytes, blood gas study.
- *Postoperative care:*
 - Continue monitoring. Monitor urine output.
 - Ventilatory assistance may be needed.
 - IV fluid. Nutritional care.
- *Postoperative complications:*
 - Hepatic coma
 - Fulminant hepatorenal failure.

Ruptured/dissecting Abdominal Aortic Aneurysm

- A ruptured or dissecting abdominal aortic aneurysm is a most serious condition and it needs urgent surgical intervention. It presents as acute lower abdominal pain with hypotension. There may be loss of femoral pulse. It usually ruptures anteriorly into retroperitoneum with severe low back pain with radiation to the groin. Diagnosis is confirmed by ultrasonography.
- Common coexisting vascular diseases include myocardial infarction, congestive heart failure, cor pulmonale, chronic obstructive pulmonary disease, hypertension, diabetes mellitus, renal dysfunction and so on.
- *Preoperative evaluation:*
 - Patient needs extensive check-up before anesthesia.
 - Past history of any disease
 - Any medication like digitalis, beta blockers, calcium channel blockers, diuretics, etc.
 - Any addiction: Drug, alcohol, smoking
 - Any coagulation disorder.

- *Investigations:*
 - Blood examination
 - Blood biochemistry : Urea NPN, sugar, electrolytes
 - Urine analysis
 - Chest X-ray
 - ECG
 - Coagulation studies
- *Preoperative preparation*
 - Cardiac medications, if any should be continued.
 - Continue bronchodilators.
 - Anxiolytic drugs may be needed.
 - IV fluid therapy.
 - Sufficient blood should be available. Fresh frozen plasma, platelets are also needed.
 - Analgesics are avoided as these will relax the tense abdominal muscles allowing the aneurysm to rupture further.
 - Two free flowing IV infusions sets (with large bore IV catheters) should be used. One of the drip lines should be a central venous line. It is also useful to measure CVP.
 - Place diathermy pad in place. Apply the monitors like pulse oximeter, ECG, sphygmomanometer, etc. Pulmonary artery catheter is also needed.
 - Check the anesthetic machine and other equipment in good order. A working suction apparatus should be kept ready at hand.
 - Patient should be well prepared. Nurses and surgeons should be ready. Expert anesthetist and one senior assistant should be prepared to administer anesthesia.
 - Resuscitation equipment and drugs should be readily available.

- *Anesthesia:*
 - Induction
 - Preoxygenation
 - Crash induction technique
 - Sleep dose of thiopentone and suxamethonium.
 - Cricoid pressure, rapid endotracheal intubation.
 - Cuff should be inflated immediately after intubation.
- Maintain anesthesia with 70% nitrous oxide and 30% oxygen and increments of analgesics (opioid) and muscle relaxants like pancuronium, vecuronium. Inhalation agents can also be given, whenever needed.

Blood pressure should be well maintained. Blood transfusion may be indicated. Fluid replacement should be done carefully. Crystalloids/colloids should be used judiciously.

Aortic cross-clamping increases after load and can cause left ventricular failure. It should be detected in time. PCWP increases, stroke volume decreases with reduction of cardiac output. Cardiac ischemia may occur. Early treatment with nitroglycerin or nitroprusside is recommended. Aortic clamping can also cause ischemia of lower extremities.

Suprarenal cross-clamping impairs renal perfusion even more than infrarenal clamping.

Cross-clamping above celiac and superior mesenteric arteries causes profound visceral ischemia and acidosis.

Aortic declamping can cause profound hypotension. It can be minimized by slow release of the cross-clamp, omission of vasodilators, fluid infusion, blood transfusion, phenylephrine, inotropes, etc.

- *Postoperative care*
 - Patient should be sent to intensive care unit.
 - Continue ventilatory assistance.

- Continue monitoring of vital signs, CVP, pulse oximetry, blood gas studies, pulmonary artery pressure.
- Judicious fluid therapy. Blood transfusion.
- *Postoperative pain relief*: It is better done with continuous epidural analgesia by catheter technique.
- Urine output should be monitored. Fluid administration to force diuresis of 1 ml/kg/hour is essential. Mannitol, furosemide and/or dopamine may be indicated to induce diuresis.
- Antagonism with protamine increases the risk of hypotension.
- *Postoperative complications*:
 - Hypotension
 - Hypertension
 - Renal failure
 - Paraplegia due to anterior spinal artery syndrome.
 - Large volume of blood is transfused, thus hazards of massive blood transfusion are there.

Acute Pancreatitis

- Acute pancreatitis is a serious condition with clinical manifestations of severe epigastric pain with radiation to the back, nausea and vomiting, restlessness and profound shock. The diagnosis is confirmed upon finding a raised serum amylase.
- It is often associated with gallbladder disease, alcoholism, hypercalcemia, lipid abnormalities, virus infection.
- The condition may be fulminant and then the features include prolonged intestinal ileus, severe hypocalcemia, hypomagnesemia, impaired carbohydrate intolerance, coagulation defect, circulatory collapse, septicemia, renal failure, pleural effusion and respiratory failure.

Treatment

- Fluid and electrolyte therapy
- Treat the metabolic acidosis
- Analgesics
- Antispasmodics
- Calcium gluconate IV to treat hypocalcemia.
- Insulin
- Antibiotics
- Nutritional care, parenteral nutrition.
- *Specific therapy:*
 - Glucagon
 - Peritoneal lavage in the form of dialysis
 - Glucose/insulin infusion
- Treat the complications, if any.
 - Infection
 - Coagulation defect
 - Renal failure
 - Respiratory inadequacy
- Role of surgery in acute pancreatitis is not much clear. But it may be considered:
 - if a necrotizing hemorrhagic mass is present, excision of pancreas (leaving the head *in situ*)
 - in presence of biliary tract disease, restoration to patency of common bile duct.
 - Laparotomy to institute peritoneal lavage.
- As the condition is mostly grave and it needs multidisciplinary approach management, the patient is better treated in intensive care unit.

Injury of the Diaphragm

It may be due to either blunt or penetrating trauma. Blunt trauma is commonly large and radial and mostly occurs posterolaterally. It may be associated with other intra-abdominal injuries. Penetrating injury is initially small but may enlarge overtime. It is commonly left sided.

Manifestations

- History of direct trauma over abdomen.
- Association of chest injury, rib fractures.
- Penetrating injury of chest/abdomen
- *Chest X-ray*: Elevation of diaphragm, nasogastric catheter enters the left side of thorax. Intestines inside the thorax.

Tear of right side of diaphragm is difficult to diagnose due to contact of liver over the defect.

- CT scan
- Direct visualization following laparoscopy.

Management

- Resuscitation with IV fluid therapy, oxygenation.
- Repair is mostly needed following laparotomy. In some cases, thoracotomy is indicated to reduce large herniation.
- Other associated injuries should be tackled as per demand.
- A standard general anesthesia with adequate muscle relaxation is needed.

CHAPTER 9

Anesthesia for Emergency Neurosurgery

Anesthesia for emergency neurosurgical procedures is mostly problematic and may be vital to get a successful outcome of the surgery. So it needs a clear understanding of the underlying physiology and pathophysiology before the conduct of neuroanesthesia.

INTRACRANIAL PRESSURE (ICP)

The normal cerebrospinal fluid (CSF) pressure usually varies between 40-160 mm of cerebrospinal fluid (about 3-12 mm Hg) measured in the horizontal position with the spine and external occipital protuberance in the same plane. Intracranial pressure may be raised due to various causes:

- Presence of space occupying lesion. Neoplasm, abscess, hematoma.
- Pressure from outside : Bony tumor, craniostenosis
- Edema of brain tissue.
- Hydrocephalus due to obstruction of CSF pathways
- Disturbance of cerebral hemodynamics as in air encephalography.
- Ischemia of brain due to trauma or vascular disease.
- Increased cerebral blood flow, head down position.
- Venous obstruction.
- *Arterial dilatation*: Raised intracranial pressure (ICP) may be further increased by general anesthesia, hypoxia, hypercarbia, coughing, straining, relaxation of arteriolar sphincters, etc.

Effects of Raised Intracranial Pressure (ICP)

- Headache, vomiting, altered consciousness
- Papilledema, impaired vision.
- Paralysis of oculomotor nerve: Ptosis, external strabismus, dilatation of pupil.
- Medullary coning
- Hampering normal vascular supply to pons, medulla and hypothalamus.

Methods of Lowering Intracranial Pressure (ICP)

- Ventricular tap
- Controlled spinal drainage of CSF
- IV hypertonic solutions
 - Mannitol
 - 20% urea in invert sugar
 - 50% sucrose
- Oral glycerol
- Head-up tilt
- Reduction of blood pressure, induced hypotension
- Hyperventilation
- Hypothermia
- Steroids, dexamethasone

Methods of Preventing Rise of Intracranial Pressure (ICP) during Anesthesia

- *Premedication:*
Avoid drugs causing respiratory depression.
- *Induction of anesthesia:*
 - Maintain a perfect airway and adequate ventilation.
 - Avoid coughing and straining
 - Nondepolarizing muscle relaxants can be used. If suxamethonium is used, precurarization is essential.
- *Maintenance of anesthesia:*
Avoid straining. A perfect airway and ventilation should be maintained. Avoid high concentration of volatile Anesthetics. Avoid hypoxia and hypercarbia. Controlled ventilation with muscle relaxants is preferred.
- *Postoperative care:*
Avoid hypoxia, hypercarbia. Maintain normal arterial oxygen and carbon dioxide tensions. Avoid coughing, vomiting and straining.

Decreased ICP may occur following:

- Blood loss, hypotension, dehydration
- Removal of extradural hematoma
- Removal of space occupying lesion.

Effect of Drugs and Techniques

- *Arterial CO₂ tension:*

CO₂ is a powerful cerebral vasodilator. Hypocapnia causes decreased ICP and can cause excellent operating conditions at craniotomy. Hypercapnia increases ICP due to increased cerebral blood flow and vascular congestion.

- *Arterial pressure:*

Hypertension can easily occur in light plane of anesthesia, response of tracheal intubation, skin incision, etc. It can increase the bulk of brain tissue, moreover there is risk of hemorrhage. Hypotension causes reduction of brain bulk.

- *Anesthetic drugs:*

- Volatile anesthetics cause cerebral vasodilation, increase CBF and ICP. N₂O is also cerebral vasodilator.
- Thiopentone, althesin and etomidate cause reduction of ICP, but ketamine increases CBF and ICP.
- Opioids have little effect on cerebral hemodynamics provided there is no respiratory depression.
- Diazepam can cause some reduction of ICP.
- Muscle relaxants may have some indirect effects due to their arterial pressure, venous pressure and cardiac output changes.

- *Anesthetic techniques:*

- Slight head-up tilt is mostly beneficial.
- Hypoxia, high expiratory resistance, insufficient expiratory time, coughing, straining, etc. can increase ICP.
- PEEP can increase ICP.

ANESTHESIA FOR NEUROSURGERY

Preoperative Assessment

- Presence of increased ICP, papilledema, altered consciousness, degree of neurological deficit should be recognized.
- Vomiting, dehydration should be assessed.
- General medical condition, if any.
- Any drug therapy: Steroids, antihypertensive or anticonvulsant drugs.
- Blood transfusion may be needed.
- Opioid or sedative premedication is usually avoided. Diazepam may be satisfactory to calm the patient. Atropine sulphate can be given to reduce secretions.
- Routine investigations including blood exam, blood biochemistry, ECG, blood gas study.

Induction of Anesthesia

- Avoid the drugs which cause increase in ICP.
- Avoid hypoxia and hypercarbia by all possible ways.
- Avoid pressor responses during laryngoscopy and endotracheal intubation.
- A nasogastric tube helps suction of the gastric contents.
- Preoxygenation, hyperventilation and full muscular relaxation help to get satisfactory condition.
- Monitoring:
 - Arterial blood pressure and pulse rate
 - ECG
 - Body temperature
 - CVP
 - Pulse oximetry
 - Expired CO₂ concentration
 - Blood gas studies
 - Monitoring of ICP

- An intravenous line for infusion.
- Protection of eyes, pressure areas including forehead, ears and nose.
- *Position:*
 - It should provide operative access and allow good venous drainage.
 - Avoid much flexion/rotation of neck to avoid obstruction of neck veins.
 - Supine brow-up position

Lateral or lateral/prone position with some rotation of neck:
Temporal or posterior fossa operation.

Prone position: For posterior fossa and cervical spine operation.

Sitting posture is not much recommended because of danger of air embolism and should be avoided, if practicable.

Maintenance of Anesthesia

- A patent clear airway.
- Intermittent positive pressure ventilation (IPPV), Hyperventilation with N_2O and O_2 , muscle relaxants in intermittent doses.
- Adequate depth of anesthesia, fentanyl can be used.
- Alternatively total IV technique can be employed in suitable cases.
- At the end of anesthesia, adequate decurarization and smooth extubation are needed.

Postoperative Care

- Continued ventilatory assistance may be needed.
- Steroid therapy in anticipation of cerebral edema.
- Continued monitoring.
- Phenytoin may be needed in presence of convulsion.
- Adequate nursing care, nutritional care, care of the eyes, bowel and bladder.

COMMON NEUROSURGICAL EMERGENCIES

- *Trauma:* Subdural hematoma, depressed fracture skull, acute brain swellings, acute extradural hematoma.
- Chronic intracranial mass developing sudden increase in mass due to bleeding or edema.
- Acute obstruction of CSF pathway : Acute hydrocephalus, medullary coning.
- Pituitary apoplexy caused by hemorrhage into the pituitary gland.

Management of Patients with Head Injuries

- Role of the anesthetist in the care of head injuries is to provide anesthesia for extracranial or intracranial surgery and to take the medical and resuscitative care of head injuries admitted in ICU. The aim is to prevent secondary brain injury by limiting focal cerebral ischemia, preventing cerebral hypoxia and maintaining adequate cerebral perfusion.
- These unconscious patients should be nursed in semiprone position with slight head down slope. Airway should be cleared of blood, vomit, secretions, etc. An artificial airway may be needed to prevent respiratory obstruction. Endotracheal intubation may be necessary where airway, cough and swallowing reflexes are impaired.
- Movement of head and neck should be extremely cautious as it may be associated with fracture of cervical spine.
- Hypotension and shock are rare in closed head injuries. But if it occurs, it indicates associated other injuries. Hypotension should be treated urgently, otherwise neuronal damage is increased.
- A thorough clinical examination is needed. Neurological deficit should be assessed.

- Glasgow coma scale can be used for clinical assessment. It is based on eye opening, verbal and motor response. Each response is given a score, high for normal and low for impaired. These responsiveness are added, the lowest score is 3 and highest is 15. Patients with score 8 or less are considered as severe head injury.

Eye opening	Spontaneous	4
	On verbal	3
	On pain	2
	No response	1
Motor response	Verbal obeys	6
	Localizes	5
	Flexion withdrawal	4
Pain stimulus	Flexion abnormal	3
	Extension	2
	No response	1
	Verbal response	5
Verbal response	Oriented	5
	Disoriented	4
	Inappropriate words	3
	Incomprehensive sounds	2
Total 3-15	No response	1

Classification of head injury based on Glasgow coma scale:

Mild:

- Glasgow coma scale 13 to 15
- Brief period of unconsciousness
- Prognosis excellent
- Mortality less than 1%

Moderate:

- Glasgow coma scale 9 to 12
- Patient is confused, focal neurological deficit
- Prognosis good
- Mortality less than 5%

Severe:

- Glasgow coma scale less than 8
- Coma, unable to follow commands
- Mortality high

- Most survivors suffer disabilities.
- Elevated ICP commonly leads to death and neurologic disability.

Note: Loss of consciousness essentially indicates head injury.

- Care of the eyes, bowel and bladder, adequate nursing care, nutritional care
- *Investigations:*
Standard hemogram, blood biochemistry, urine exam. X-ray, scans, arterial blood gas study. CT scan are the essential diagnostic tests of head injury.
- *Intensive care:*
 - Control of raised ICP
 - Position
 - Oxygenation
 - Controlled ventilation
 - Sedation in selected cases
 - Steroids
 - Diuretics: frusemide
 - Fluid balance (intake and output)
 - Electrolyte balance
 - Anticonvulsants to prevent or treat convulsions
 - Early diagnosis and evacuation of hematoma are essential.

Anesthesia for Patients with Head Injury

- Emergency surgery is usually indicated in patients with rapid deterioration unconscious level or sudden appearance of unilateral neurological signs. Extradural hematoma, depressed fractures, CSF rhinorrhea not associated with simple malar fractures need emergency surgical intervention. Anesthesia may also be needed for treatment of other associated injuries in presence of head injury.

- Patients with head injury are always at risk of increased ICP, compressed brain and increased neurological deficit. Look for level of consciousness, maintenance of airway, any bleeding and associated injuries.
- *Preanesthetic assessment:*
 - A full history and physical examination.
 - All investigation reports to be reviewed.
 - An oropharyngeal airway is helpful. Patient is better nursed in lateral, semiprone position.
 - Oxygenation, avoid hypoxia and hypercarbia.
 - Assess the cardiovascular status. Hypotension can reduce cerebral perfusion significantly. Rising blood pressure and falling pulse rate may be associated with papilledema and altered conscious level.
 - Associated thoracic cage injury may cause pneumothorax or hemothorax. Ventilation may be severely deteriorated. Check arterial blood gases.
 - Take all precautions against vomiting and aspiration of gastric contents.
- *Anesthesia:*
 - Check the machine, all equipment, resuscitation drugs, anesthetic drugs, etc. A good assistance is also helpful.
 - Avoid volatile anesthetics as these can produce vasodilation.
 - Preoxygenation, IV thiopentone and succinylcholine, rapid sequence of induction with cricoid pressure. Long acting muscle relaxant is needed for controlled ventilation. Avoid hypoxia and hypercarbia. A cuffed endotracheal tube should be used. Avoid ketamine as it increases ICP.
 - Maintenance of anesthesia with oxygen and nitrous oxide with intermittent doses of muscle relaxants and analgesics. Analgesia is not much needed. Hyper-

ventilation is helpful. Ensure PaCO_2 reduction as it reduces ICP.

- If mannitol is needed, it is better to administer early just after induction. The urinary bladder should be catheterized.
- Fluid replacement should be made cautiously. Blood transfusion may be indicated.
- At the end of surgery adequate decurarization is needed. Ideally endotracheal extubation should be done, when the patient is well awoken. Adequacy of ventilation should be checked before extubation.
- Monitoring of vital signs, pulse oximetry, blood gas study, blood biochemistry, serum electrolytes should be done at frequent intervals.
- *Postoperative period:*
 - i. Continue monitoring
 - ii. IPPV may have to be continued.
 - iii. Adequate nursing care, nutritional care.
 - iv. *Prevention of infection:* Antibiotics
 - v. Tracheostomy may be beneficial in the prevention and treatment of respiratory infection. Bronchial lavage should be done in selected cases.
 - vi. Pulmonary edema can also occur as a complication of head injury. Avoid aspiration of gastric contents.
- Local analgesia may be a good alternative to general anesthesia in well-selected cases.

ANESTHESIA FOR SPINAL CORD COMPRESSION

- The basic principles of anesthesia are mostly identical to those adopted in other neurosurgical procedures. But some special considerations are to be borne in mind.

The aim is to prevent secondary cord injury which can be exaggerated by hypotension, shock, hypoxia, hypercoagulability and hyperthermia.

- Careful positioning is most important to allow free respiratory movement and avoid back flow on veins and increased vascularity.

Extreme care is needed while moving and positioning these cases particularly to the prone position. Excessive movement may complete a partial transection of the spinal cord or exaggerate the existing damage.

- In cervical injury, neck movement must be extremely limited or even absent, it can make the laryngoscopy and endotracheal intubation difficult. These patients may be in a rigid cervical collar or minerva plaster which poses added difficulty. All sorts of precautionary measures should be taken against anticipated difficult intubation.
- Succinylcholine should be avoided in such cases as there is significant release of potassium from the denervated muscles of the lower limb in response to succinylcholine. Serum potassium level should be checked preoperatively. Succinylcholine is safe within first 24 hours after acute injury. Pancuronium is mostly safe.
- A stomach tube is always helpful for suction of gastric contents and thereby for prevention of aspiration. The use of cuffed endotracheal tube gives adequate control of airway and prevents aspiration.
- Severe postural hypotension due to interruption of sympathetic outflow often associated with spinal injury needs adequate attention.
- Careful protection against hyperthermia.
- Preoperative hydration is needed to prevent hypotension during anesthesia.
- Acute manifestations of spinal cord transection: Spinal shock, bradycardia, hypotension, alveolar hypoventi-

lation, hypoxemia. Aspiration pneumonitis and pulmonary embolism can also occur.

Hypophysectomy

- Excision of pituitary gland is done for tumors of the gland and for treatment of metastatic hormone sensitive tumors.
- These patients may be anemic and cachectic. Multiple bony metastases, pleural effusion and ascitis are common. Thus the patient should be properly evaluated before anesthesia and surgery. All sorts of investigations need to be reviewed.
- Steroid replacement should be started before operation. But other hormones may have to be given postoperatively.
- Laryngoscopy and endotracheal intubation may be difficult in patient with acromegaly. They may need extra long laryngoscopes and endotracheal tube introducer for smooth intubation.
- Postoperatively some patients may show severe hypothalamic disturbances of temperature and circulatory regulation.

LOCAL ANESTHESIA FOR NEUROSURGERY

Indications

- Minor neurosurgical procedures like burr-hole biopsy, ventriculography particularly when intracranial pressure (ICP) is raised.
- Neurosurgical procedures where patient's cooperation is needed during the operation.
- When general condition of the patient contraindicates general anesthesia.
- In cases where general anesthesia is hazardous and patient needs emergency intervention as in rapid increase of ICP.

Advantages of Local Anesthesia

- Further increase of ICP as occurs in general anesthesia does not arise.
- Airway remains patent. Chance of aspiration of gastric contents to lungs is always less.

Disadvantages

- Lengthy operations cannot be done.
- Not suitable for
 - Uncooperative patients, anxious, tense patients.
 - Patients with convulsion.
 - Children.

Contraindications

History of allergic reaction on local anesthetic drugs.
Sepsis on the injection site.

CHAPTER 10

Emergency Anesthesia for Cardiothoracic Surgery

INTRODUCTION

Anesthetic management for emergency cardiothoracic surgery may include initial resuscitation, airway evaluation and management, intraoperative anesthetic care and postoperative intensive care management. These patients usually require a specially designed operation theater with a team of expert specialists and trained nurses for the optimal care.

Preanesthetic Assessment

- In addition to general assessment some other factors specified to thoracic surgery are to be considered.
 - *History:* The common symptoms may include dyspnea, cough, hemoptysis and dysphagia.
 - Dyspnea is a common symptom indicating disease of lungs or airways, cardiac disease or anemia. The degree of dyspnea should be evaluated. It may be due to asthma or chronic bronchitis, mucosal edema and secretions in the small airways.
 - Cough may be either dry or productive. Dry cough is due to irritation of large airways. Productive cough may be due to infection.
 - Hemoptysis may be due to bronchiectasis and cavitating pulmonary tuberculosis, or tumor of the lung.
 - Dysphagia may be due to infection, obstruction, tumor of esophagus. Pressure from outside can also cause dysphagia.
- *Physical examination:* Careful examination of the cardiovascular and respiratory system is essential.
- *Investigations:* Full blood count, serum urea, NPN, sugar, electrolytes. ECG, coagulation study, liver function tests. X-ray chest. Pulmonary function test in selected cases to assess the extent of impairment of lung function.

- *Preparation for surgery:*
 - Stop smoking
 - Antibiotics
 - Preoperative physiotherapy, breathing exercises
 - IV fluid therapy, rehydration
 - Correction of electrolyte imbalance, if any
- *Premedication:*
 - It is mostly according to the need of the patient.
 - Anticholinergic drug may be helpful to reduce the secretions.
 - A large gauge IV cannula is essential for infusion of fluid and blood.
- *Anesthesia for thoracotomy*
 - Induction of anesthesia with IV anesthetic agent like thiopentone and a muscle relaxant like suxamethonium or nondepolarizing agent, pancuronium.
 - Tracheal intubation with a cuffed endotracheal tube, IPPV.
 - Maintenance of anesthesia with N_2O , O_2 , and IV opioid and muscle relaxant.
 - Patient's position should be according to the need of surgery. Lateral or semilateral position is usually undertaken. Prone position can also be done with necessary precautions to prevent pressure to the abdomen.
 - Monitoring of vital signs, heart rate and blood pressure, ECG, CVP, temperature, pulse oximetry, blood gas analysis, etc. is useful.
 - At the end of operation, the pleural cavity is drained to prevent air or fluid accumulation. The collapsed lung, if present should be reinflated gently.
 - After closure of the thorax the drains should be connected to an underwater seal. It helps to drain the air/fluid with little resistance and measures the

drained fluid. During IPPV, the air comes out of the pleural cavity and helps for expansion of lungs.

- Following reversal of muscle relaxants and return of adequate spontaneous ventilation and regain of airway reflex, extubation should be done.
- *Postanesthetic care:*
 - Adequate oxygenation and elective mechanical ventilation
 - IPPV may have to be continued.
 - Continued monitoring
 - *Effective analgesia:*
 - i. IM or IV opioids
 - ii. Patient controlled IV infusion of opioid
 - iii. Intercostal block
 - iv. Paravertebral or extradural block (catheter technique)
 - v. Intrathecal opioids
 - Antibiotics
 - Tracheobronchial toilet
 - Adequate nursing care
 - Avoid hypoxia, hypercarbia and hypotension.
 - Physiotherapy to help lung expansion.

Removal of Inhaled Foreign Body

- Inhalation of foreign bodies is common in children. A large object can obstruct the larynx completely and may end fatally within a short period of time. But smaller objects can pass in the upper airway more distally to cause a valvular obstruction or a total obstruction leading to distal consolidation and collapse.
- There is always some irritation, inflammation and edema at the local site. It is associated with acute respiratory distress, pulmonary infection and hypoxia.

- *Management:*
 - In dire emergency where there is complete obstruction in larynx, a sharp squeeze around the thorax or slap on the back while head is held down, may be helpful to throw out the foreign body.
 - Rigid bronchoscopy without anesthesia may help to cough out the object.
 - Cricothyroid jet ventilation, if available.
- *Anesthesia:*
 - The procedure is highly critical and requires skill and experience.
 - Assess the degree of respiratory distress.
 - No sedation. Antisialogogue agent can be given IV
 - The anesthesia machine, other equipment, drugs, light and sucker machine should be in good working order.
 - Tracheostomy set should be kept ready.
 - Ensure IV drip.
 - Preoxygenation. Inhalational anesthesia is always preferred. Endotracheal intubation can be done.
 - Removal of foreign body should be performed through a rigid bronchoscope. Bronchial edema may cause some difficulty.
 - Oxygenation should be continued. Humidified oxygen is preferred.
 - Laryngeal stridor can occur in immediate postoperative period. Patient needs close observation for at least 24 hours.
 - Tracheostomy may be needed in extreme cases.

AIRWAY BURN

- It is the thermal or chemical injury to the mucosa of the airway. It may be due to overheated steam or gases from the direct exposure to closed space fires, smoke and toxic

gases. It can also occur from the ignition of endotracheal tube during laser surgery in the pharynx, larynx or tracheobronchial tree.

- *Manifestations:*

- Smell of burning, smoke.
- Burned nasal mucosa, lips, mouth ulcers.
- Congestion, airway edema, edematous cords.
- Hypoxemia, low PaO_2 .
- Bronchospasm
- Adult respiratory distress syndrome
- Carbon monoxide poisoning

- *Management:*

Laser ignited fire:

- Oxygen flow should be stopped and the patient is disconnected from the breathing circuit.
- The damaged endotracheal tube should be removed and mask ventilation with 100% O_2 started.
- Reintubation is attempted. If not possible, transtracheal jet ventilation, cricothyrotomy or even tracheostomy.
- Mechanical ventilation
- Adequate resuscitation, IV fluids, steroids, supportive care.

Overheated gases fire:

- Source of heat (heater, humidifier) needs removal.
- Assess the extent of airway burn and treat.
- Early endotracheal intubation and mechanical ventilation.
- Adequate oxygenation.
- Supportive care, antibiotics, steroids
- Fiberoptic bronchoscopy.

Prevention:

- Use laser proof endotracheal tube.
- Tracheal tube cuff should be filled with saline.

- Avoid nitrous oxide. Maintain low oxygen content in inspired gases.
- Monitor the patient all the while during surgery
- Protection against fire hazard.

Complications:

- Hypoxia
- Pneumothorax, pneumonia
- Permanent lung injury, pulmonary fibrosis

AIRWAY RUPTURE

- It is mostly due to mechanical or thermal injury, direct blow to the trachea, penetrating trauma, gunshot injury, during laser surgery of airway, during instrumentation of the airway, etc. There may be perforation or disruption of a part of the airway.
- *Manifestations:*
 - Acute respiratory distress, dyspnea, loss of normal contour of the thyroid cartilage.
 - Hypoxemia, cyanosis
 - Blood in the sputum
 - Subcutaneous emphysema
 - Pneumothorax
 - Chest X-ray: Pneumothorax, pneumomediastinum
 - Airleak from penetrating chest trauma
 - Difficulty in intubation and efficient ventilation.
- *Management:*
 - Adequate oxygenation and ventilation
 - Endotracheal intubation. Secure the airway.
 - Fiberoptic bronchoscopy is helpful for tracheo-bronchial toilet.
 - Double lumen endotracheal tube may be useful in selected cases of tracheal/bronchial rupture.
 - Adequate resuscitation, supportive care.
 - Sedatives and analgesics in low doses.

- Surgical intervention is the definitive treatment. Emergent incision and intubation of the disrupted distal trachea may be needed in extreme cases.
- *Complications:*
 - Hypoxemia
 - Airway obstruction
 - Infection : Pneumonia, lung abscess
 - Tracheal/bronchial stenosis
 - Cardiac arrest

TRACHEOSTOMY

- *Indications:*
 - To relieve upper airway obstruction
 - For long-term IPPV
 - Tracheobronchial toilet
 - To prevent inhalation of foreign materials in cases of failure of swallowing or absence of laryngeal reflexes
 - Extensive orofacial trauma
- *Advantages:*
 - Overcomes upper airway obstruction
 - Reduces dead space significantly
 - Allows effective tracheobronchial toilet
 - Allows prolonged ventilatory support.
- *Anesthesia:*
 - Patient should be under general anesthesia and intubated except for emergency cases.
 - Emergency tracheostomy can be done under local anesthesia.
 - Tracheostomy set and other resuscitation equipment and drugs, suction apparatus and operating light should be available.
 - Adequate monitoring of vital signs, pulse oximetry, ECG is essential.

- Position the patient to extend the neck.
- Low tracheostomy should be avoided.

Tracheal intubation is contraindicated in facial trauma and laryngeal obstruction.

- *Side effects of tracheostomy:*
 - Loss of voice
 - Loss of expulsive cough
 - Loss of nasal humidifying effect.
- *Complications:*
 - Loss of the airway
 - Tube misplacement/dislodgement
 - Tracheal laceration
 - Hemorrhage
 - Pneumothorax
 - Laryngeal nerve injury
 - Tracheal ulceration/stenosis
 - Erosion of innominate artery
 - Tracheoesophageal fistula.

FIBEROPTIC BRONCHOSCOPY

- *Indications:*
 - Removal of foreign bodies
 - Tracheobronchial toilet
 - Adjunct to endotracheal intubation
 - Evaluation/diagnosis of acute inhalation injury, bronchial injury, hemoptysis.
- Preanesthetic requisite :
 - It can be done in intubated patients or for endotracheal intubation.
 - An expert bronchoscopist is essential
 - Patient should be evaluated beforehand.
 - Adequate monitoring including cardiac and pulse oximetry, ECG is required.

- Equipment including bronchoscope, means of ventilation, jet ventilation, mechanical ventilator, suction apparatus, etc. should be kept ready.
- Adequate oxygenation should be maintained all the while during the procedure.
- *Anesthesia:*
 - Premedication : Sedatives/analgesic IV in small doses. Only atropine may be given.
 - Local anesthesia: Lignocaine 20 to 30 ml.
 - General anesthesia in children: N₂O, O₂ and halothane.
- *Contraindications:*
 - Unwilling patients
 - Patients with severe hypoxia and/or hypercarbia
 - Asthmatic patients.
 - Myocardial ischemia.
 - Severe pulmonary hypertension
- *Postoperative care:*
 - Nothing by mouth for atleast 2 hours.
 - Humidified oxygen
 - Continued monitoring of vital signs
 - Watch for signs of stridor.
- *Complications:*
 - Hypoxemia
 - Cardiac arrest
 - Bronchial ulcer/infection.

PNEUMOTHORAX

- It is the presence of air in the pleural cavity either from penetrating injury of chest wall or from a leak of air from the lung or bronchus.
Common causes of pneumothorax causing impaired ventilation are:
 - Penetrating wound of the chest, rib fractures.

- Chronic obstructive airways disease, chronic bronchitis, asthma.
- Newborn
- Bronchiectasis, bronchial carcinoma
- Patients on IPPV (barotrauma)
- Severe staphylococcal pneumonia
- Following CVP line placement, regional block of nerves such as intercostal nerve block, stellate ganglion block, supraclavicular brachial plexus block.
- Following surgery in close proximity to pleural cavity: Nephrectomy, splenectomy, percutaneous liver biopsy.
- Following bronchoscopy, esophagoscopy.
- During laparoscopy due to CO₂ insufflation.

Classification of Pneumothorax

- *Simple*: Here a leak of air occurs causing a lung collapse to some degree. But the amount of air is constant and it seals automatically or following removal of air. The lung re-expands.
- *Open*: Here the leak between lung and pleural cavity is open and air continues to leak out replacing the removed or absorbed air.
- *Tension pneumothorax*: Here a valve system occurs at the leak and the volume of air increases in the pleural cavity with each inspiration. It may be dangerous to cause severe dyspnea and collapse. Immediate needling of the chest is essential.
- *Manifestations*:
 - Cough, tachypnea, dyspnea, cyanosis, hypoxemia, hypercarbia, tachycardia, hypotension, chest pain.
 - Asymmetric breath sounds, on percussion hyper-resonant affected part.

- Tracheal deviation.
- Distended neck veins.
- Chest X-ray : Mediastinal shift, loss of lung markings, visible edge of partially collapsed lung.
- *Treatment:*
 - Confirm the diagnosis.
 - IV fluid infusion to expand the circulating volume.
 - Vasopressors may be needed.
 - A large bore IV catheter or a chest tube is inserted into the pleural space. It is to be attached to underwater seal. The catheter should be inserted either in 2nd intercostal space, midclavicular line or in 4th intercostal space, midaxillary line.
- Note:* The swing of fluid in the drainage system indicates its patency. If tension pneumothorax is relieved, hemodynamic improvement will occur.
- Expert thoracic surgeon is needed, If it
 - is bilateral
 - remains open
 - is recurrent.
- Serial X-ray chest will indicate the re-expansion of lungs. The chest drain should be removed once air bubbling has stopped.
- If the expansion of lung is well maintained after clamping the catheter for several hours, it can be removed safely.

Open Pneumothorax

It can be caused by injury and destructive penetrating wound. A large open wound in chest wall greater than two-thirds of the tracheal diameter allows the path of air entry through least resistance through the chest wall with each inspiration. It will lead to severe hypoventilation and profound hypoxemia. The condition needs early management.

Management

- Early endotracheal intubation, if the patient is in respiratory distress.
- The wound over the chest wall needs sterile occlusive dressing.

Note: Avoid securing the dressing tightly on all sides, if no chest tube is inserted. Otherwise it can produce tension pneumothorax.

- Thoracostomy of the affected side is needed. Avoid placing the chest tube through or near the chest wound.
- Urgent thoracotomy is performed to evacuate the blood clots. Large defect needs flap closure. A chest tube should be kept in place.

Massive Hemothorax

- Massive hemothorax can occur in penetrating chest injuries due to hilar or systemic blood vessels. Intercostal and internal mammary vessels are commonly injured. Each hemithorax can hold significant volume of blood, may be up to 3 liters.
- *Manifestations:*
 - Injury chest
 - Tachycardia, tachypnea, respiratory difficulty, low blood pressure, hemorrhagic shock.
 - Breath sounds on the affected side diminished or even absent.
 - Dullness on percussion
 - Neck veins collapsed, but may be distended due to mechanical effects of hemothorax.
 - Chest X-ray shows unilateral opacity.
- *Management:*
 - Adequate oxygenation.
 - Controlled ventilation, with endotracheal intubation
 - IV fluid therapy, vasopressors.

- Blood transfusion
- Tube thoracostomy with wide bore catheter in fifth intercostal space.
- Second chest tube may be needed to drain the hemothorax adequately.
- Thoracotomy may be needed in extreme cases.

Anesthesia for Emergency Tube Thoracostomy

It is usually done under local anesthesia at the local site with 1% lignocaine including the skin, periosteum, subpleural space and pleura.

Pericardial Tamponade

- It is mostly due to penetrating injury of the chest. It is also seen in blunt chest trauma. About 75 to 100 ml blood can accommodate in the pericardial sac and can cause adverse cardiac functions.
- *Manifestations:*
 - Patient is seriously anxious and in discomfort.
 - Persistent hypotension, metabolic acidosis, profound shock.
 - Muffled heart sounds.
 - Pulsus paradoxus.
 - Pulmonary artery catheter : Right and left side heart pressures seem to equalize. CVP approaches to pulmonary artery wedge pressure and both are elevated.
 - Ultrasound examination.
 - X-ray chest
- *Treatment:*
 - Adequate volume resuscitation. IV fluid therapy. Blood transfusion.
 - Adequate oxygenation. Endotracheal intubation.
 - Pericardiocentesis as a temporary measure.
 - Definitive pericardiotomy.

CONSIDERATIONS FOR CARDIAC SURGERY

Preanesthetic assessment is most vital for safety and outcome of the surgical procedures. But urgency of the proposed operation becomes a dominant factor for complete assessment and preparation of the case. Knowing fully the operative risks and hazards, it becomes necessary to compromise the situation tactfully as far as practicable. However, the awareness of the presence of heart disease and its associated problems make the anesthetist more conscious and faithful for the patient care.

The preanesthetic assessment and investigations including monitoring and the choice of proper anesthesia are of immense importance for the safety of the patient and outcome of surgical procedures.

Preoperative Assessment of Cardiovascular System

- History is most important. Common symptoms include
 - Dyspnea
 - Ischemic pain
 - Palpitations
 - Syncope
 - Enquire about past history of diseases like rheumatic fever, hypertension, venous thrombosis, diabetes, etc.
 - Complications of previous operation, childbirth, if any should be noted.
- Physical examination of cardiovascular system including heart. Pulse, blood pressure, jugular venous pulse and pressure, heart sounds, murmurs if any, cardiac enlargement, etc are to be noted.
- *Preoperative drug therapy*: These may have adverse interactions with other drugs used during anesthesia and surgery.

- Digitalis
- Beta blockers
- Calcium antagonists
- Nitrates
- Diuretics
- Anticoagulants
- *Investigations:*
 - Exercise electrocardiography
 - Cardiac catheterization
 - Echocardiograph
 - Radionuclide imaging
 - Full blood count
 - Coagulation studies
 - Serum electrolytes
 - Blood urea, NPN, sugar
 - Liver function tests
 - Pulmonary function tests
 - Radiological : Chest X-ray
- Extensive and accurate monitoring in perioperative period should always be done.
 - Clinical monitoring, pulse, blood pressure, respiration, body temperature.
 - Electrocardiogram
 - Arterial pressure, pulse oximetry
 - Central venous pressure
 - Left atrial pressure
 - Cardiac output
 - Core temperature
 - Blood gas analysis
 - Blood biochemistry, serum electrolytes
 - Urinary output, urine analysis.
- *Preoperative preparation:*

Cardiac disease can affect the patient's response of anesthesia and surgery and increases the operative risk

significantly. Some relative contraindications to elective surgery are cardiac failure, recent myocardial infarction etc.

Management of heart failure:

- Adequate rest
- Controlled balanced diet. Maintain glycogen reserve.
- Preoperative IPPV
- Digitalis, diuretics, vasodilators
- Tapping in presence of ascitis/pleural effusion.

Myocardial infarction:

- Risk of anesthesia is high within 15 days of infarction.
- Normal risk if the infarct is 3 months old, no feature of congestive heart failure, no angina and ECG is near normal.

Heart block:

- If the heart block is caused or increased by increased vagal tone, it is advised to give atropine sulphate in large doses preoperatively.
- If the block is unstable or the patient is in failure, a temporary pacemaker is advised preoperatively. It is usually done under local analgesia. In such cases diathermy is better avoided as it can affect the pacemaker function and can cause ventricular fibrillation.

Note: Thyrotoxicosis can cause atrial fibrillation and heart failure. It should be treated along with its cardiac effects.

- The risk of perioperative complications is significantly increased with some factors:
 - Age is above 65 years.
 - Unstable angina pectoris or myocardial infarction within 6 months to operation.
 - Emergency surgery or reoperation
 - Poor left ventricular failure
left ventricular end-diastolic pressure (LVEDP) more than 18 mm Hg

Ejection fraction less than 40 percent
 Cardiac index less than 2 lit/min/m²
 Dyskinetic wall motion.

- Raised pulmonary artery pressure
- Presence of right heart failure
- Co-existing diseases such as diabetes

BLUNT CARDIAC INJURY

It can cause clinically significant hemodynamic changes due to injury of the myocardium.

- *Dysrhythmias*: Sinus tachycardia, premature atrial contractions, atrial fibrillation, premature ventricular contractions.
- Acute heart failure
- Valvular injury
- Cardiac rupture
- Asymptomatic myocardial muscle contusion can also occur.

Diagnosis is mostly difficult, but can be done with

- 12 lead ECG
- Echocardiography to detect wall motion and valvular competency

Risk factors include:

- Forceful chest impact.
- Precordial ecchymoses, contusion, tenderness
- Fracture sternum, thoracic spine, rib fractures
- Hemodynamic instability
- Elderly patient

Management

- Complete bedrest
- Resuscitation, IV fluid infusion Blood transfusion
- Monitoring of ECG. Pulmonary artery catheter
- Patients with ischemic changes should be treated as with myocardial infarction.

- Emergency noncardiac surgery may have to be done with proper care and precautions under general anesthesia.
- Surgical drainage of pericardial effusion (pericardiotomy /pericardiectomy)

Penetrating Injury of Heart

- The patient is in profound shock and cardiovascular collapse. Stab weapon if present in place should not be taken out until the patient is taken in operating room and thoracotomy is done.
- Cardiovascular resuscitation. IV fluid therapy, large volume of blood transfusion needed. Pericardial tamponade, if present needs urgent pericardiocentesis.

Anesthesia may be induced with ketamine IV and maintained with N_2O , O_2 and inhalation anesthetic, whenever necessary, IPPV is helpful.

Continuous monitoring of vital signs, ECG, blood gas studies is essential.

Some patients with penetrating cardiac wounds may show overt clinical manifestations of cardiac injury. Pericardial ultrasonography or a pericardial window may be indicated for diagnosis.

Injury Caused by Cardiac Catheterization

- It is the complication of cardiac catheterization. Cardiac arrhythmia, ventricular tachycardia and even ventricular fibrillation can occur during introduction of catheter. It may not be much problematic, if the catheter is withdrawn in time.
- Perforation of atrial or any other heart chamber is a serious complication and needs immediate surgical intervention. Diagnosis is mostly confirmed by fluoroscopic examination.

CARDIAC LACERATION

It is mostly due to inadvertent incision into the right atrium, right ventricle or great vessels during sternotomy. These patients usually have a history of previous sternotomy and have adhesion of myocardial tissue to the sternum.

Associated Factors

- Emergency situation
- Ascending aortic aneurysm
- Deformed chest
- Associated chest injury

Clinical Manifestations

- Sudden profuse blood loss, hypotension, cardiovascular collapse.
- Acute heart failure.

Management

- IV line should be adequate for rapid infusion.
- IV fluid therapy : Blood transfusion to maintain circulating blood volume.
- Vasopressors to maintain perfusion pressure.
- Immediate surgical repair with cardiopulmonary bypass.

Complications

- Myocardial ischemia
- Cardiac dysrhythmias, air embolism
- Cardiac arrest

CHAPTER 11

Emergency Anesthesia for Eye, Ear, Nose and Throat Surgery

EMERGENCY ANESTHESIA FOR EYE SURGERY

Anesthesia for ophthalmic procedures needs a clear understanding and knowledge of ocular anatomy and physiology particularly with reference to intraocular pressure, oculocardiac reflex and interaction between ophthalmic drugs and perioperative medications.

INTRAOCULAR PRESSURE (IOP)

Normal intraocular pressure is 10 to 20 mm Hg. Aqueous humor is formed in the ciliary body by active secretion in front of the iris and is eliminated through the canal of Schlemm at the episcleral venous system and then to the superior vena cava.

Factors Regulating the IOP

- External pressure exerted by extraocular muscles, eyelid and orbicularis oculi.
- Volume of arterial and venous vasculature.
- Volume of aqueous and vitreous.
- Scleral rigidity.

Factors Lowering IOP

- Anesthetic agents (except N_2O).
- Arterial hypotension.
- Hyperventilation.
- Retrobulbar block.
- Manual massage of globe.
- High blood PaO_2 .
- *Drugs:*
 - *Osmotic agents:* Mannitol, urea, glycerol.
 - *Carbonic anhydrase inhibitors:* Acetazolamide.
 - *Miotics:* Narcotics.

- *Acid-base defect*: Respiratory alkalosis, metabolic acidosis.
- Neuroleptics, narcotics, tranquillizers.
- Hypothermia.

Factors Increasing IOP

- Increased venous pressure: Coughing, bucking, retching, vomiting.
- Squeezing.
- Hypoxia.
- Hypercarbia.
- Suxamethonium.
- Atropine in narrow angled glaucoma.
- Trendelenburg's position.
- Light anesthesia.
- Essential hypertension.
- Pancuronium, ketamine.
- Hypervolemia.
- Ephedrine, phenylephrine, etc.

OCULOCARDIAC REFLEX

Traction of the extrinsic muscles of the eye can result in bradycardia and even cardiac arrest. Other arrhythmias such as nodal rhythm, atrioventricular block, pulsus bigeminus, etc. can also occur. This is due to oculocardiac reflex and is mediated on the efferent side by the cardiac fibers of vagus nerve.

Prevention

- Retrobulbar block.
- Atropine sulphate in adequate dose.
- Careful monitoring of pulse or preferably the use of electrocardiogram.
- Resuscitation drugs and equipment should be readily available.

Surgical Requirement during Intraocular Surgery

- Control of IOP is vital. Moderate reduction of IOP is beneficial. Sudden reduction in pressure in cases of raised IOP may lead to extrusion of ocular contents through the wound. Hemorrhage can also occur from short ciliary vessels. Retinal detachment surgery may also be easy to perform.
- Complete immobility of the eye.
- No straining, coughing, vomiting should occur.

Ocular Emergency Requiring Immediate Treatment

- Thermal or chemical corneal injury/burns. Copious fluid washing is most helpful.
- Central retinal artery obstruction. Needle aspiration of the globe can decrease intraocular pressure and thus can relieve arterial obstruction.
- Narrow-angle glaucoma. If IOP cannot be controlled medically, emergency iridectomy may have to be done.
- *Ruptured globe:*
 - It is a relative emergency. Urgency depends on the patient's vision at the time of assessment.
 - Coughing, straining, nausea and vomiting should not occur, otherwise there is a chance of extrusion of ocular contents.
 - If the patient is in full stomach, surgery can be delayed for some hours for gastric emptying.
 - Adequate preoperative check-up is needed before administering anesthesia.
 - Other craniofacial injuries may be there and these should be assessed by computed tomography, ocular ultrasound and angiography.
 - In such cases surgeons should be consulted along with ophthalmologist and may have to operate together.

- *Threatened perforation of corneal ulcer:* Emergency corneal graft can save the eye.

Penetrating Eye Injury

Problems

- Patient may have full stomach.
- An increase of IOP may cause loss of ocular contents.
- Other injuries may also be present.
- May be anatomically difficult to intubate.
- May have other medical condition.

Management

- Assess the patient carefully.
- Anesthesia can be delayed for a suitable period to minimize the risk of full stomach.
- Patient should be kept calm and quiet while waiting for operation.
- Anesthetic equipment, suction apparatus should be kept ready.
- Intubation must be as smooth as possible. Crash induction may be helpful. But suxamethonium can cause a rise of IOP. A large dose of nondepolarizing muscle relaxant (vecuronium, atracurium) can be used.
 - Care should be taken not to exert pressure over the injured eye by facemask.
 - Endotracheal intubation.
 - Anesthesia maintained with $N_2O + O_2 +$ halothane.
 - Avoid hypoxia and hypercarbia as these can increase IOP.
 - At the end of operation adequate decurarization should be done.
 - Extubation should be done when the patient on his side and almost awake. Try to avoid making the patient cough.

- Antiemetic drugs (ondansetron) can be given to prevent vomiting.

EMERGENCY ENT ANESTHESIA

- Smooth anesthesia along with a clear patent airway is essential.
- Coughing and straining cause venous congestion and can cause increased bleeding.
- Partial obstruction of the airway may lead to hypoxia and hypercarbia.
- Patients may have coexisting medical diseases, so careful preoperative assessment is essential.
- The shared airway: The airway is shared by both surgeon and anesthetist.
- The airway must be protected by proper endotracheal intubation. Oropharynx may have to be packed to avoid contamination with blood, secretions, etc.
- A Boyle-Davis gag can compress the endotracheal tube and cause some obstruction.
- Extubation should be done in a head down position and when almost awake.

POSTOPERATIVE BLEEDING TONSIL

Postadenotonsillectomy bleeding usually occurs within the first 8 hours of operation. But it can also occur 7 to 10 days postoperatively at the time of falling eschar from the operative site.

Manifestations

- Signs of hypovolemia: Tachycardia, hypotension, pallor, sweating.
- Swallowing of blood is common. Patient is assumed to be as in full stomach.
- Vomiting, retching, straining, hiccough.
- Pain.

Management

Early surgical ligation of bleeding vessels is essential.

- Proper assessment of the physical status. Think of bleeding and/or clotting disorder.
- Intravascular volume replacement. Crystalloid solution. Blood transfusion may be needed.
- *Essential monitoring:* Blood pressure, pulse oximeter, precordial stethoscope, ECG, capnograph.
- Induction of anesthesia should be attempted only after restoration of intravascular volume.
- Patient should be placed in head down lateral position and suction apparatus should be kept ready.
- *Induction of anesthesia:* Thiopentone followed by suxamethonium, rapid sequence induction with cricoid pressure.
- Endotracheal intubation. Cuff should be inflated.
- Maintenance of anesthesia with intermittent doses of analgesic and muscle relaxant. IPPV.
- Gaseous induction with halothane in oxygen may also be tried. But it increases the risk of hypotension, laryngospasm and aspiration of gastric contents.
- Etomidate or ketamine may be helpful in cases with hypotension.
- After control of bleeding surgically, the stomach is evacuated through a nasogastric tube.
- At the end of procedure, the pharynx is cleared and patient turned to lateral position and extubation done gently avoiding coughing, retching and straining.
- After extubation, oxygenation should be continued. Suction apparatus should be kept ready.
- Blood loss should be estimated and replaced by blood transfusion.
- Stormy emergence can cause rebleeding from the surgical site.

Pharyngeal Abscess

- *Manifestations:* Severe pain, trismus, difficulty in deglutition, rise of body temperature, respiratory obstruction.
- Assess the airway.
- *Management:*
 - Abscess should be drained or decompressed by aspiration under local anesthesia.
 - General anesthesia may be risky as the condition poses difficult endotracheal intubation due to distorted anatomy, trismus.
 - Danger of rupture of abscess with pus contaminating the airway.
 - Tracheostomy under local anesthesia may be done to secure the airway.
 - Antibiotics

Epistaxis

- Bleeding through the nasal cavity.
- Usually aged patient, may be hypertensive.
- Assess the physical condition of the patients. Patient may be hypovolemic, tachycardiac, pale and anxious.
- Restore the blood volume. IV fluid infusion.
- Blood may be swallowed and thus the patient is in full stomach.
- *Management:*
 - Packing the nose and postnasal space.
 - Surgical intervention to control bleeding from the nose.
 - Ligation of the maxillary artery.
- *Anesthesia:*
 - Every attempt should be made to prevent vomiting and aspiration pneumonitis.
 - Rapid sequence induction of anesthesia. Thiopentone followed by suxamethonium, cricoid pressure.

Orotracheal intubation. Cuff inflated, maintenance with $N_2O + O_2$ + halothane or intermittent doses of relaxants.

- Orogastric tube may be inserted for gastric suction.
- Sucker machine should be kept ready to use.
- Monitoring of vital signs is essential.

Acute Epiglottitis

- Bacterial infection of epiglottitis usually by *Haemophilus influenzae*.
- Common in children.
- *Manifestations:*
Sudden onset of stridor, dysphagia, glottic swelling, muffled voice, toxic, febrile, cherry red swollen epiglottis, respiratory obstruction, dyspnea.
- *Management:*
 - IV infusion.
 - Antibiotics.
 - Humidified oxygen.
 - Airway should be assessed. Intubation with tracheostomy may be necessary.
 - Children usually need intubation.
 - Anesthesia induced by inhalation of 100% oxygen with halothane. Intubation may pose difficulty. ENT surgeon should be present, tracheostomy may have to be done. Initially oro-tracheal intubation is done, but subsequently it should be replaced by nasal tube when a clear airway is established.

TRACHEOSTOMY

- *Indications:*
 - Obstruction in the upper respiratory tract.
 - Inability to cough-up secretions.
 - Failure of swallowing or absence of laryngeal reflexes.
 - For long-term IPPV.

- *Anesthesia:*
 - Best performed under general anesthesia with an endotracheal tube *in situ*. The airway is protected from bleeding and tracheostomy can be done meticulously. When the trachea is opened, the endotracheal tube should be withdrawn, so that the tip remains in the larynx to allow insertion of tracheostomy tube. In cases of any difficulty, the endotracheal tube can be reinserted.
 - Local anesthesia can be employed, if the endotracheal intubation is impossible or extremely difficult.
- *Side effects:*
 - Loss of voice.
 - Loss of expulsive cough.
 - Reduction of respiratory dead space.
 - Loss of nasal humidification.
- *Complications:*
 - Hemorrhage.
 - Infection.
 - Tracheoesophageal fistula.
 - Tracheal stenosis.
 - Erosion of innominate artery.

Note: Tracheostomy is a life-saving measure. It should be performed by experts. It needs extra care and good management.

FOREIGN BODIES IN ESOPHAGUS

- Most common in children, in elderly edentulous patients and mentally impaired patients.
- Variety of foreign bodies: Coins, meat bolus, dentures, fishbone, safety pin, etc.
- Usually lodges in narrow parts like upper esophageal sphincter, the level of aortic arch, diaphragmatic hiatus.

- *Manifestations:* Vague discomfort in chest or neck, dysphagia, excessive salivation, stridor, dyspnea.
- X-ray or endoscopic examination confirms the foreign body.
- *Management:*
 - Endoscopic removal. But airway should be protected.
 - Esophagoscopy removal of foreign body can be done under local or general anesthesia.
 - Foreign bodies should be removed as early as possible and be treated as emergency.
- *Complications of foreign body in esophagus:*
 - Impaction.
 - Esophagitis/periesophagitis.
 - Perforation.
 - Paraesophageal abscess.

Foreign Bodies in Larynx/Tracheobronchial Tree

- Foreign body in larynx and tracheobronchial tree is one of the important causes of stridor and dyspnea in infants and children.
- Nature of the foreign body can vary. It may be metallic, pin, coin, vegetables like peas, beans, meat bolus, vomitus, food material, etc. Large foreign body can cause total or partial respiratory obstruction.
- Foreign body lodged in larynx produces a change of voice. There may be complete asphyxia which is further aggravated by glottic edema.
- Foreign body in the trachea causes dyspnea with stridor. Depending on the type of obstruction, asthmatic type of wheezing can be heard.
- Foreign body in bronchus can cause respiratory obstruction which may be either partial or complete.
- Neglected foreign body can cause bronchiectasis, lung abscess, empyema.

- Foreign body causing complete airway obstruction leads to cardiac arrest.
- *Investigations:*
 - X-ray chest and neck
 - Bronchoscopy
 - Arterial blood gas analysis.
- *Management:*
 - Foreign body in the larynx and subglottic area are removed by direct laryngoscopy.
 - Foreign body in trachea and bronchi are removed by bronchoscopy.
 - Impacted foreign bodies in bronchus may require thoracotomy under general anesthesia.

Note: Once the diagnosis of upper airway obstruction is made, one must proceed immediately to the urgent management.

General Guidelines for Emergency Management of Upper Airway Obstruction

- Establish/improve the airway as far as possible.
- Ventilate the patient by mask with 100% oxygen
- Intubation should be attempted, if needed.
- If ventilation and intubation fail, try to oxygenate transtracheally through a plastic catheter inserted through cricothyroid membrane. Transtracheal ventilation should not be tried.
- Tracheostomy.
- Once ventilation is established, cardiovascular instability should be treated.
- Then treat the etiology of the hypoventilation.

CUT-THROAT INJURY

- It may be suicidal, homicidal or accidental.
- It may involve great vessels of the neck only. Severe blood loss occurs leading to hypovolemic shock. Bleeding should be stopped and patient should be resuscitated with IV fluid and vasopressors. Blood transfusion is needed. Following adequate resuscitation, proper repair of the wound should be undertaken under general anesthesia. Patient should be nursed in head down position to prevent air being sucked into an open vein.
- It may involve larynx/trachea only. Here the maintenance of a clear patent airway may become problematic. It may cause airway obstruction, aspiration to lungs and airleak producing pneumothorax. Adequate clearing of the airway is most important. Risk of aspiration should be borne in mind and adequate preventive measures should be taken. IV fluid infusion and vasopressors may be needed. Following resuscitation, anesthesia may be induced by passing the endotracheal tube through the cut end of larynx/trachea and administering inhalational agents. Later the endotracheal tube can be passed through the oral cavity under the direct vision with the aid of laryngoscope. The surgical procedure may need a repair of larynx/trachea with a temporary tracheostomy. Adequate tracheobronchial toilet and care is most important.
- Both the great vessels of the neck and airway may be involved. The condition is most serious as it needs urgent cardiovascular resuscitation and restoration of a clear patent airway. Risk of aspiration and air embolism is also present.

CHAPTER 12

Emergency Anesthesia and Common Pre-existing Medical Diseases

HYPERTENSION

It is a rise in arterial blood pressure of more than 20% above the baseline. Chronic elevation in blood pressure above 140/90 mm Hg.

Types

- *Essential (primary) hypertension*: No identifiable cause.
- Secondary hypertension:

Causes

- *Renal diseases*: Pyelonephritis, glomerulonephritis, diabetic nephropathy, renal artery stenosis
- Coarctation of aorta.
- *Endocrine diseases*: Cushing's disease, pheochromocytoma, primary aldosteronism.
- Drug effect, oral contraceptives, alcohol
- Intracranial hypertension.

Management of Anesthesia

Preoperative Assessment

- Evaluation of laboratory data
- Clinical examination meticulously, check the blood pressure whether it is adequately controlled or not.
- Enquire about the medication, antihypertensive drugs, associated organ dysfunction, if any.
 - Orthostatic hypotension
 - Cerebrovascular disease
 - Ischemic heart disease
 - Kidney dysfunction
 - Peripheral vascular disease

Preanesthetic medication: Analgesics, anxiolytic drug. Continue the antihypertensive drugs perioperatively.

Induction of Anesthesia

Try to avoid exaggerated blood pressure changes during laryngoscopy and endotracheal intubation.

- *Methods:*

- Deep general anesthesia with a volatile anesthetic is needed during laryngoscopy.
- Short-acting opioid (fentanyl) may be tried before the procedure.
- Lignocaine may be sprayed to anesthetise laryngotracheal mucosa.
- IV lignocaine
- Esmolol
- Nitroprusside

Note: Laryngoscopy should be of brief duration.

Maintenance of Anesthesia

- $N_2O + O_2$ + volatile anesthetic agent.
- $N_2O + O_2$ + intermittent doses of opioids and muscle relaxants, IPPV.
- Avoid drugs causing increase of blood pressure.
- Monitoring of vital signs, ECG and pulse oximetry is vital. Invasive monitoring is useful in cases of emergency surgery with uncontrolled hypertension.
- Fluid therapy should be judicious.
- Regional anesthesia may be helpful in cases with hypertension, if not otherwise contraindicated.

Postoperative Care

- Postoperative monitoring of vital signs is essential. Hypertension can always occur.
- Analgesics.
- Avoid fluid overload.
- Increased blood pressure needs treatment with opioids, hydralazine, labetalol, nitroprusside.

Beware the risks of myocardial ischemia, cardiac arrhythmias, heart failure, stroke or excessive hemorrhage.

Congestive Heart Failure

- It may have two pathophysiologic types, systolic dysfunction and diastolic dysfunction.
- *Systolic dysfunction*: Here the ability to pump blood is affected, ejection fraction is diminished. It is usually due to coronary artery disease, myocarditis, dilated cardiomyopathy, regurgitant vascular disease, hypertension, etc.
- *Diastolic dysfunction*: Here the heart is unable to relax and allow adequate diastolic filling. Ejection fraction is mostly normal. It is usually due to ischemia, aortic stenosis, cardiomyopathy, hypertension with left ventricular hypertrophy, etc.
- Clinical manifestations are due to left-sided failure or right-sided failure or both.
- *Left ventricular failure*: Dyspnea on exertion, orthopnea, paroxysmal nocturnal dyspnea, fatigue, tachycardia, rales, acute pulmonary congestion/edema, oliguria.
- *Right ventricular failure*: Systemic venous pressure elevated, fatigue, malaise, hepatomegaly, dependent edema, ascitis.
- *Treatment*:
 - *Systolic dysfunction*: Vasodilators like ACE inhibitors, angiotensin II receptor blockers, beta blockers, spironolactone, low sodium diet, diuretics, digitalis.
 - *Diastolic dysfunction*: Beta blockers, calcium channel blockers, low sodium diet, diuretics.
- *Anesthetic implications*:
 - It is better to avoid surgery in such cases, surgery can be deferred, if it is practicable. But in real emergency cases general anesthesia may be needed and in such cases the aim should be to optimize the cardiac output.

- Volatile anesthetics should be used cautiously. Ketamine and opioids may prove beneficial.
- IPPV is always indicated to decrease pulmonary congestion and better oxygenation.
- Dopamine or dobutamine can help to support the cardiac output.
- Drug interactions with digitalis need attention.
- Regional anesthesia may be indicated in selected cases. But the risk of arterial hypotension is always there.

Mitral Stenosis

- It is caused by rheumatic heart disease and may have history of rheumatic fever.
- Clinical manifestations include dyspnea, orthopnea, paroxysmal nocturnal dyspnea, hemoptysis. These may be precipitated by fluid overload, tachycardia, pregnancy, salt load, etc.
- ECG may show left atrial abnormality, atrial fibrillation. Echocardiogram can confirm the diagnosis. It can quantify the severity.

Treatment

- Salt-restricted diet
- Diuretics
- In presence of atrial fibrillation, ventricular rate can be controlled with beta blockers, calcium channel blockers.
- Anticoagulation
- Balloon valvuloplasty
- Surgical valve replacement.

Anesthesia

- The primary aim should be to avoid further decrease of cardiac output. Avoid tachycardia and marked increase in central blood volume as in overtransfusion, head down tilt. Hypoxemia, and hypoventilation must be avoided as

these may exaggerate pulmonary hypertension and cause right heart failure.

- Rapid atrial fibrillation can be treated with cardioversion or IV infusion of esmolol. Sudden decrease in systemic vascular resistance can be treated with ephedrine or phenylephrine.

Pulmonary hypertension and right heart failure should be managed with dopamine and pulmonary vasodilation with nitroprusside.

- *Preoperative assessment and preparation:*
 - Avoid anticholinergic drugs.
 - Prophylactic antibiotics.
 - If the patient is digitalized, the drug should be continued.
- *Induction and maintenance of anesthesia:*
 - Avoid ketamine and pancuronium as these can increase pulse rate.
 - Avoid drugs causing sudden hypotension.
 - $N_2O + O_2$ and opioid or low concentration of volatile anesthetic is most suitable.
- Monitoring of vital signs, pulse oximetry, ECG, CVP, etc.
- *Postoperative care:*
 - Continue cardiac monitoring
 - Intermittent positive-pressure ventilation (IPPV) may have to be continued.
 - Risk of pulmonary edema and right heart failure is always there.

Ischemic Heart Disease

Patient over the age of 40 years may have symptomless ischemic heart disease. Patient with history of myocardial infarction within 3 months carries considerable risk of reinfarction. Elective surgery is better postponed within 6 months, but emergency surgery may have to be done but with adequate precautionary measures.

Unstable angina, if present should be treated with beta blockers, nitrates and calcium channel blockers before surgery.

Further reinfarction may be precipitated by factors like increase of myocardial work and oxygen consumption and decrease of coronary blood flow. Diagnosis of ischemic heart disease is most important.

- *History:* Angina pectoris, history of myocardial infarction, exercise tolerance, coexisting diseases like peripheral vascular disease, diabetes, chronic obstructive airway disease, etc. Current drug therapy with beta blockers, nitrates, aspirin, etc.
- *Manifestations:* Dyspnea, pain chest, orthostatic hypotension, any sign of left ventricular failure.
- Chest X-ray.
- ECG.
- Echocardiography.
- Radioisotope imaging.
- Coronary angiography, left ventricular angiography.
- Cardiac catheterization.

Anesthesia

- Congestive failure, if present needs treatment with diuretics and digoxin.
- *Anxiolytic drugs:* Diazepam.
- Provision of maximum sedation and amnesia without cardiovascular and respiratory depression.
- Continue the current medications to treat ischemic heart disease.
- Induction and maintenance of anesthesia:
 - Maintain heart rate and blood pressure near normal awake value.
 - IV induction agents are mostly satisfactory, but avoid ketamine.
 - Laryngoscopy should be of short duration.

- Take precautions against cardiovascular changes related to laryngoscopy and intubation.
- Volatile anesthetic agents to minimize increased sympathetic nervous system activity and increased O_2 requirements.
- Vecuronium, doxacurium and pipecurium may be used as muscle relaxant. Avoid pancuronium.
- Reversal should be adequate at the end of anesthesia.
- Monitoring of vital signs, pulse oximetry, CVP, pulmonary artery catheter is needed.
- Postoperative pain relief is most important. Continue monitoring in postoperative period. Control the pulse rate and blood pressure.

Note: If myocardial ischemia is detected on ECG during anesthesia and surgery, the following steps may prove useful:

- Esmolol in presence of tachycardia.
- Nitroglycerin if blood pressure is either normal or elevated.
- Sympathomimetic drugs like ephedrine or phenylephrine.
- Cautious intravenous therapy in presence of decreased blood pressure.

Heart Block

- Preoperative assessment of the extent of the conduction deficit is important by ECG.
- History of syncopal attack or in presence of heart failure, permanent pacing is needed.
- A temporary pacing should be done in cases of complete heart block, second degree heart block or first degree heart block with bifascicular block (right bundle branch), block with left anterior or posterior hemiblock)
- The patients of heart block should always be monitored on ECG continuously. A stand by pacemaker should always be available.

- Avoid undue blood loss and/or vasodilation in cases with heart block.
- Anesthesia in patients with pacemaker:
 - Careful history and physical examination. History of ischemic heart disease, hypertension, arrhythmia, diabetes, etc. Investigations should include blood examination, blood biochemistry, ECG, chest X-ray, coagulation studies.
 - Enquire about the pacemaker, the date of insertion, indication of insertion, type of pacemaker, date of changing battery, any complication, etc.
 - Pacemaker function should always be checked preoperatively.
 - Drugs and equipment for CPR should be available. Electrical defibrillator, external converter magnet should be available. Drugs like atropine and isoprenaline may be needed.
 - Routine general anesthesia is mostly satisfactory. Anesthetics usually do not alter the stimulation threshold of artificial pacemaker. Suxamethonium is mostly safe, but fasciculations caused by it may inhibit a functioning pacemaker by causing contraction of skeletal muscles.
 - i. Proper oxygenation is essential. Avoid hypoxia, hypercarbia and hypotension.
 - ii. Diathermy should be avoided as far as practicable in cases of demand pacemakers. However, it can be converted to fixed rate type pacemaker by applying a high powered magnet. Fixed rate pacemakers are mostly resistant to external interferences and diathermy can be used with all possible sensible precautions.

- iii. The grounding plate should be placed as far as possible from the pacemaker to minimize detection of the current by the pulse generator.
 - iv. The cautery must not be used within 15 cm of the pacemaker.
 - v. The use of cautery should be minimal and may be limited to 1 second bursts every 10 seconds to prevent repetitive and prolonged asystolic periods.
- Continuous monitoring of pulse, blood pressure and ECG is essential.
- Isoprenaline injection may be needed, if pacing fails.
- *Regional anesthesia:*
 - It is always preferred as it offers freedom from respiratory complications and avoids the ill effects of general anesthesia.
 - Spinal or epidural anesthesia may be given, if not otherwise contraindicated.
 - The use of extradural analgesia by catheter technique postoperatively can reduce hypoxemia and minimize pulmonary complications.
 - Opioids, if used should be given in a minimum dosage.

Bronchial Asthma

- The disease is characterized by recurrent generalized airways obstruction, smooth muscle spasm, mucus plugs and bronchial edema. Episodic wheezing, cough, dyspnea, chest tightness, prolonged expiratory time, pulsus paradoxus and cyanosis in severe cases. Peripheral eosinophilia is common.
- *Preoperative assessment:*
 - *History:* Predisposing factors, frequency and severity of attacks. Medication.

- Physical examination.
- Pulmonary function test, blood gas studies in severe cases.
- Elective surgery should be done after the full control of asthma. However, emergency surgery may have to be done after the management of acute attack with all care and precautions.
- An appropriate bronchodilator drug should be given with the premedication. A sedative (diazepam) with atropine is helpful to block vagal reflex induced bronchospasm. Pethidine and promethazine can also be tried.
- *General anesthesia:*
 - Laryngoscopy and endotracheal intubation can initiate bronchospasm. Laryngeal spray with lignocaine, or IV lignocaine may be helpful. Intubation should be done in deeper plane of anesthesia.
 - Volatile anesthetics like halothane and ether are bronchodilators.
 - Avoid drugs which can release histamine (morphine, tubocurarine, atracurium)
 - Pancuronium, pethidine, and fentanyl are mostly satisfactory.
 - Avoid drugs like beta blockers.
 - Intermittent positive-pressure ventilation (IPPV) should be cautious. Slow inspiration flow rate provides maximum distribution of ventilation to perfusion.
 - Adequate IV fluid therapy.
 - Extubation should only be done when anesthesia is sufficient to suppress airways reflexes.
- *Regional anesthesia:*

It is always preferred, if not otherwise contraindicated.

Intraoperative Bronchospasm

Causes

- Obstruction in the airway.
- Light plane of anesthesia.
- Aspiration of gastric contents.
- Endobronchial intubation.
- Pneumothorax.
- Pulmonary edema.
- Actual attack of asthma.

Management

- Airway should be kept clear and patent.
- Deepen the anesthesia.
- Halothane or ether may be helpful.
- *Bronchodilator therapy:* Aminophylline, salbutamol
- IV hydrocortisone can be given, but it has no immediate effect.

Thyrotoxicosis

- It is the hyperactivity of thyroid gland manifested by excitability, tremor, tachycardia, arrhythmias, weight loss, intolerance to heat and exophthalmos.
- Diagnosis is confirmed by increased plasma thyroxine and T_3 resin uptake. TSH is either decreased or normal.
- Elective surgery should always be done by making the patient euthyroid with thiouracil, carbimazole, potassium iodide and beta blockers. These drugs should be continued up to the time of operation.
- Emergency surgery can be done safely in hyperthyroidism using beta blockers and potassium iodide. Emergency surgery carries a risk of thyroid crisis.
- Large goiter, if present can cause airway obstruction. It should be evaluated by computed tomography.
- Avoid the drugs, like ketamine that stimulate sympathetic activity.

- Adequate deep anesthesia is needed to prevent sympathetic responses to surgical stimulation.
- Muscle relaxants should be chosen which are free from cardiovascular effects. Vecuronium, doxacurium and pipecuronium are mostly satisfactory. Avoid pancuronium and d-tubocurarine.
- As these patients are mostly associated with myasthenia gravis, muscle relaxants may cause prolonged block.
- Hypotension, if occurs should be treated with IV fluid and directly acting vasopressors like phenylephrine.
- Regional anesthesia may be considered in appropriate cases, if not otherwise contraindicated.

Note:

- The dose of sedatives, analgesics and anesthetics should be increased to compensate for faster distribution and elimination.
- Spinal block can reduce the effects of hyperthyroidism.
- Local anesthetic solutions used in such cases should not contain adrenaline.

Thyrototoxic Crisis

- It is the exacerbation in severity of the features of thyrotoxicosis. It usually occurs in patients where thyrotoxicosis is not controlled preoperatively.
- *Manifestations:*
 - Fever, sweating, dehydration
 - Tachycardia, heart failure
 - Contusion, agitation
 - Tachypnea
- *Treatment:*
 - Correct the sympathetic overactivity
Propranolol, reserpine
 - Steroids

- Antithyroid drugs
- General measures
 - i. Cooling, icepacks
 - ii. Oxygenation
 - iii. IV glucose infusion
 - iv. Adequate nursing care

Hypothyroidism

- The disease is due to hypoactivity of thyroid gland and can occur from primary thyroid failure; secondary to pituitary failure.
- Clinical manifestations include lethargy, fatigue, tiredness, dry skin, hair loss, cold intolerance, constipation, muscle cramps, bradycardia, decreased pulse pressure, nonpitting edema of subcutaneous tissues, memory loss, BMR is decreased, cardiac output is decreased with myocardial reserve.
- Diagnosis is confirmed by low total plasma thyroxine and decreased T_3 resin uptake. TSH is increased in primary hypothyroidism and decreased in secondary hypothyroidism.
- Treatment is usually with thyroxine. Rapid correction may be done with IV tri-iodothyronine, but it should not be done in elderly patients and in patients with ischemic heart disease.
- Elective surgery should be avoided, but emergency surgery can be done with close monitoring of vital signs, cardiovascular status and blood gas analysis.
- All the anesthetic drugs, sedatives and analgesics should be used in reduced dosage due to slow drug distribution and metabolism.
- Recovery from anesthesia may be prolonged.
- Ventilatory dysfunction and cardiac dysfunction can occur.

- Myxedema coma can occur and it is manifested by stupor, coma, hypoventilation, hypothermia and hypotension.
- The disease is usually associated with adrenal insufficiency and thus steroid therapy is essential.

Cushing's Syndrome

- Hypersecretion of cortisol is caused by pituitary adenoma secreting ACTH and causing bilateral adrenocortical hyperplasia.
- Clinical manifestations include weakness, muscle wasting, weight gain, central obesity, psychosis, hirsutism, moon facies, buffalo hump, hypertension, osteoporosis, hyperglycemia, glycosuria and elevated plasma cortisol and urinary free cortisol.

A normal or high ACTH level indicates pituitary adenoma or ectopic ACTH syndrome. A low ACTH level indicates adrenal tumor.

- *Treatment:* Hypophysectomy/adrenalectomy.
- *Anesthetic care:*
 - Treat hypertension, congestive cardiac failure and hypokalemia.
 - Careful monitoring of vital signs, cardiovascular status and arterial pressure.
 - Appropriate anesthetic agents and muscle relaxants should be used.
 - Postoperative steroid cover may be needed.

Addison's Disease

- It is the adrenocortical insufficiency and may be of two types.
 - *Primary:* Caused by autoimmune process, tuberculosis, amyloid, metastatic carcinoma, following bilateral adrenalectomy, hemorrhage inside the glands so on.
 - *Secondary:* Pituitary insufficiency, prolonged steroid therapy.

- *Manifestations:*
Weakness, lassitude, weight loss, hypotension, dehydration, pigmentation, hypoglycemia, hyponatremia, hyperkalemia, profound hypotension in stress, infection. Diagnosis confirmed by plasma cortisone level, response to ACTH stimulation.
- *Anesthetic care:*
 - All patients should have steroid cover in perioperative period, IV hydrocortisone 6 hourly.
 - Fluid and sodium replacement.
 - IV glucose to combat hypoglycemia.
 - Monitoring of blood pressure, CVP.
 - Antibiotics
 - In cases of acute adrenal failure, take all possible measures to treat the shocked patients with hydrocortisone, volume resuscitation and blood pressure support.
- *Steroid cover during perioperative period:*
 - *Indications:* Pituitary-adrenal suppression patients on steroid replacement therapy, patients on steroid therapy, patients undergoing pituitary or adrenal surgery.
 - *Management:*
 - i. *For minor surgery:* Single dose of hydrocortisone 100 mg IM preoperatively.
 - ii. *For intermediate surgery:* Hydrocortisone 100 mg 6 hourly IM in premedication and for 24 hours.
 - iii. *For major surgery:* Hydrocortisone 6 hourly for 72 hours starting from premedication.

This regime can be modified in presence of infection, major trauma, sudden cardiovascular collapse, in presence of asthma and other medical conditions.

In recent recommendation, the dose is reduced as 25 mg hydrocortisone IV at the time of induction followed by 100 mg IV infusion over 24 hours for major surgery and only 25 mg IV at the time of induction for minor surgery.

In cases of adrenocortical insufficiency in emergency cases a rapid replacement is recommended:

- Hydrocortisone 100 mg IV state followed by infusion of 100 mg over 24 hours.
- Rehydration with sodium containing fluid.
- In presence of hyperkalemia calcium gluconate may be needed and if necessary, insulin should be added in glucose solution.
- Unexplained hypotension should be treated with IV hydrocortisone.

Diabetes Mellitus

- It is manifested with elevated plasma glucose level under fasting conditions. It is either insulin-dependent (Type 1) diabetes mellitus or noninsulin dependent (Type 2) diabetes mellitus.
- *Type 1*: Usually below the age of 16 years. Abrupt onset, polyuria, polydipsia, polyphagia, needs exogenous insulin. Prone to ketosis, wide fluctuations of blood glucose level.
- *Type 2*: Usually above the age of 35 years, gradual onset, may be asymptomatic, polyuria, polydipsia, polyphagia, may not need insulin, not always susceptible to ketosis. Usually obese, relatively stable but increased blood sugar level.
- Treatment includes diet, oral hypoglycemic agent and exogenous insulin administration.
- Complications may include ketoacidosis, cerebrovascular accident, myocardial infarction, cardiomyopathy, retinopathy, nephropathy, autonomic and/or sensory neuropathy, stiff joint syndrome and so on.

- *Anesthetic management:*

Main objective should be the avoidance of hyperglycemia and hypoglycemia. Blood glucose level should be kept between 120 to 200 mg % perioperatively. Monitoring of blood glucose level in frequent intervals is mandatory. Urine testing, ECG and blood gas studies are also of immense value.

- Diabetes should be well controlled before any elective surgery.
- Short-acting soluble insulin should be switched on usually on twice daily basis atleast for 3 days prior to surgery.
- Adequate hydration. Dehydration, if present should always be corrected with normal saline infusion.
- Acid base and electrolyte correction is also needed.
- Antibiotics to combat infection.
- Perioperative insulin therapy:
 - i. On the day of operation: No subcutaneous insulin. Ten percent dextrose solution, 500 ml with 10 units soluble insulin and 10 m mol of potassium chloride should be started on the day of operation. It should run for 4 to 6 hours. Subsequently fluid therapy is adjusted according to blood sugar level.
 - ii. *Postoperative period:* Infusion of dextrose solution with soluble insulin is continued until oral intake is established. Subcutaneous insulin is given after re-establishment of oral intake.
- Anesthesia:

General anesthesia is mostly satisfactory. Avoid drugs like ether, cyclopropane etc. which can produce hyperglycemia. Controlled ventilation with muscle relaxants is mostly safe. Avoid hypoxia, hypercarbia and hypotension. Intraoperative hypoglycemia should always be prevented.

Regional anesthesia is a good alternative and provides some definite advantages. It reduces the stress responses and metabolic responses to surgery. It reduces the incidence of nausea and vomiting and hence pulmonary complications. Postoperative diabetic control is somewhat easy.

- In cases of emergency surgery, the patient's metabolic status should be assessed and all sorts of precautionary measures should be taken.

Diabetic Ketoacidosis

- It is the metabolic acidosis due to increased level of ketoacids such as acetoacetic acid and beta hydroxybutyric acid in the blood and urine in diabetic patients.
- It results from inadequate insulin dosage or increased insulin requirement often precipitated by sepsis, stress, injury, surgery, etc.
- *Clinical manifestations:* Nausea, vomiting, pain abdomen, dehydration, hypovolemia, hyperglycemia, metabolic acidosis, confusion, coma.
- Management should aim at
 - Control of blood sugar by soluble insulin
 - Correction of dehydration.
 - Correction of acid-base and electrolyte imbalance.
- *Preanesthetic preparation:*
 - Adequate oxygenation and ventilation
 - *Adequate fluid management:* Expansion of circulating fluid volume with normal saline infusion with CVP monitoring.
 - Soluble insulin 20 units IV and IV infusion at 10 units per hour. Low doses of insulin 6 to 8 units per hour by continuous infusion is also very effective.
 - Potassium supplementation is needed to prevent hypokalemia under ECG control.

- Bicarbonate may be needed in some selected cases.
- Antibiotics
- Once blood sugar starts falling, it indicates insulin is being effective, then and only then surgery can be started.
- *Emergency anesthesia:*
 - Nitrous oxide, oxygen and relaxant technique is mostly satisfactory.
 - Intermittent positive-pressure ventilation (IPPV)
 - 'Crash induction' for prevention of acid aspiration syndrome.
 - Careful monitoring of blood gas studies, blood sugar, urea, electrolytes, ECG and arterial pH.
 - Reversal of muscle relaxants may be impaired in presence of metabolic acidosis. Postoperative ventilatory assistance may be needed.
 - Continue diabetic management postoperatively.

Emergency Anesthesia and Liver Disease

- Pre-existing liver disease may have serious adverse effects on the conduct of anesthesia. Anesthesia itself can adversely affect the liver function.
- Common liver diseases like jaundice, ascitis, cirrhosis of liver, hepatic failure, etc. should be carefully assessed and investigation reports, if any should be consulted.
- Routine investigations should include standard hemogram, coagulation studies, estimation of serum bilirubin, alkaline phosphatase, transaminases, urea, electrolytes, sugar and protein, etc.
- Common problems related to anesthesia:
 - Acid-base imbalance.
 - Electrolyte irregularities
 - Fluid overload

- *Bleeding problems:* Clotting factors II, VII, IX and X are reduced due to poor absorption of vitamin K. Platelets and fibrinogen reduce.
- *Hepatorenal syndrome:* Jaundice patients are prone to develop renal failure often precipitated by hypovolemia.
- *Drug metabolism:* Liver dysfunction can slow elimination of drugs including anesthetics and muscle relaxants. Altered plasma protein concentration affect drug binding and can alter drug effect, some drugs may have toxic effects on liver.
- Hepatic failure may cause
 - i. Neuropsychiatric disturbances, hepatic encephalopathy
 - ii. Jaundice
 - iii. *Hemorrhagic manifestations:* Decreased clotting factors, thrombocytopenia, intravascular coagulation.
 - iv. *Metabolic changes:* Hypoglycemia, renal failure, acid-base and electrolyte disturbances.
- *Anesthetic implications:*
 - Avoid hypoxia, hypercarbia and hypotension
 - Cardiac output should be maintained as stable as possible. Blood loss should be replaced. Blood transfusion should be cautious. Fresh blood is preferred.
 - Drugs causing hypotension or depressing hepatic blood flow should be avoided.
 - No sedatives, analgesics should be given in premedication.
 - Avoid halothane and cyclopropane.
 - Pancuronium is said to be the relaxant of choice. Atracurium is also good.
 - Opioid drugs should be used with caution and in low dosage.

- Controlled ventilation to a normal PaCO_2 is recommended.
- Adequate monitoring of vital signs, CVP, ECG, pulse oximetry, blood gas studies, blood glucose, serum electrolytes, etc. is essential.

Emergency Anesthesia and Renal Disease

- Renal dysfunction may cause serious problems during anesthesia. A careful preoperative assessment is most important even in emergency cases.
- History and clinical examinations are needed. Pre-existing hypertension or proteinuria may be there. History of recurrent urinary tract infection, calculi, exposure to toxic drug or chemicals, analgesic abuse, etc. should be taken into account. Common causes of chronic renal failure are glomerulonephritis, pyelonephritis, polycystic kidney, some diseases such as diabetes mellitus, malignant hypertension, lupus erythematosus, etc.
- *Common investigations:* Full blood count, hemoglobin concentration, blood biochemistry (urea, NPN, sugar), electrolytes, urine volume, urine analysis, coagulation studies, ECG, chest X-ray and even blood gas studies may be needed in selected cases.
- Some specific problems need careful attention in preoperative assessment.
 - *Fluid balance:* Fluid overload is common in such cases. Hypertension and congestive heart failure can result. Overload can be controlled by diuretics. Dialysis may be needed in severe cases.
 - Edema and ascitis can occur in nephrotic syndrome. These may be associated with reduced circulating blood volume.
 - Electrolyte disturbances are common and sodium retention occurs in renal failure. Associated water

retention, edema and hypertension may also be there. Hyponatremia can also occur in pyelonephritis, analgesic nephropathy and diuretic therapy.

- Hyperkalemia occurs in renal failure along with metabolic acidosis. It should always be treated with infusion of glucose saline, calcium chloride, ion exchange resins, or even dialysis. Hypokalemia may be caused by prolonged diuretic therapy. It is associated with ventricular irritability in patients receiving digoxin.

- *Cardiovascular disturbances:* Hypertension, hypertensive heart diseases and cardiac failure are common in renal failure.

Uremia can cause pericarditis and pericardial effusion. Pulmonary and peripheral edema, fluid overload, hypoproteinemia may also be associated.

- *Neurological disturbances:* Uremia can cause drowsiness, coma and peripheral neuropathy. Electrolyte changes affect the mental alertness and conscious level. Sedatives and analgesics should be used cautiously in such cases.

- Patients with renal failure usually suffer from anemia, malnutrition.

- Patients with dialysis also pose various problems.

- These patients may have drug treatment (diuretics, antihypertensives, etc.) which cause interaction with anesthetics.

- *Anesthetic implications:*

- Premedication should be light. Small doses of benzodiazepine or opioids can be given.

- IV fluid infusion should be cautious and it needs careful monitoring of CVP. Avoid fluid overload and potassium containing fluids.

- Blood loss should be monitored. Blood transfusion may be needed.

- Drugs primarily excreted through the kidneys should not be used. Muscle relaxants like gallamine and fazadinium should be avoided. Atracurium is the relaxant of choice as its elimination is independent of renal and hepatic function.
- Volatile anesthetic agents are mostly satisfactory, but methoxyflurane and enflurane should always be avoided.
- Meticulous monitoring during anesthesia and in postoperative period is essential.
- Regional anesthesia is a good alternative to general anesthesia provided it is not contraindicated.

CHAPTER 13

Miscellaneous

EMERGENCY OPERATION THEATER

The emergency operation theater should have generous floor space to allow for the various apparatus such as anesthetic machine and accessories, monitoring equipment, suction apparatus, operating table and to accommodate surgeon, anesthetist, house staff, nurses and other personnels to work smoothly. It should locate far away from infectious ward to prevent cross-infection. Preanesthetic room and post-operative recovery room should be in adjoining space. There should be a waiting room for patients nearby. It should be fully airconditioned. Ancillary rooms should include nurses, surgeon's and anesthetist's office. Technical staff are also involved in the maintenance and sterilization of equipment.

The emergency operating room should be fully equipped as with cold operation theater. The readily available other apparatus should include mechanical ventilator, humidifier, oxygen mask and cardiac monitors. Resuscitation equipment and drugs should be kept in a separate trolley ready for use. A clock should also be provided to aid observations.

It should be provided with a large high quality of light, a good operation table capable of radiography and fluoroscopy, suction connections, some electrical outlets, a good anesthesia machine, mechanical ventilator, device for electrocautery, etc. There should be head light, face shield, boots and sterile gowns for the operating team.

A system should be available for the operating team to provide periodic updates to relatives/family members. Direct contact/communication between operation theater and blood bank and laboratory should also be available.

The equipment should be adequately cared for and checked at regular intervals. Anesthetic record-keeping must be a routine procedure. All these are always helpful to guard

against Consumer Protection Act. The emergency anesthetic service and care should be attempted to make it atleast a near ideal one.

The drug cupboard should be stocked with all sorts of anesthetic drugs, muscle relaxants, resuscitative drugs in common use. Full laboratory facilities including blood gas study, serum electrolyte estimation, etc. should be provided. One senior anesthetist should be incharge of the Emergency Anesthetic Service round the clock and he should be available all the time.

Intraoperative monitoring is most vital for all emergency cases. Most of them are critically ill and they may need invasive monitors.

- Standard monitors: ECG, pulse oximetry, capnography, multigas analyzer, core temperature, etc.
- Arterial line
- Central venous pressure
- Pulmonary artery catheter.
- Transesophageal echocardiography
- Neurological monitoring
 - ICP monitoring
 - EEG
- Coagulation studies.
- Peripheral nerve stimulator

Note: Difficult intubation poses problems during anesthesia and it needs critical care management to tackle the situation. Difficult intubation cart should be as follows:

- Oxygen cylinders
- Facemasks of different sizes
- Ambu bag, different sizes of rebreathing bags
- Laryngoscopes, at least 2 in working order
- Laryngoscopic blades of different sizes
- Stillets

- Endotracheal tubes: Oral and nasal of different sizes
- Pulse oximeter
- Capnography
- ECG
- Stethoscope
- Magill forceps
- Fiberoptic laryngoscope
- Laryngeal mask airway of different sizes
- Esophageal-tracheal combitube
- Jet ventilation devices
- Light wand
- Local anesthetic spray
- Cricothyrotomy set
- Tracheostomy set
- Following drugs should be readily available for cardiopulmonary resuscitation.
 - Defibrillator
 - Drugs: Lignocaine, adrenaline, procainamide, bretylium, atropine, isoprenaline, magnesium sulphate, diltiazem, dopamine, noradrenaline, dobutamine, sodium bicarbonate, nitroglycerin, nitroprusside, verapamil, etc.

SPINAL KIT

A typical prepacked sterile disposable kit for spinal anesthesia:

- 22 or 25 gauge 10 cm long spinal needle.
- Draping material.
- Standard syringes and needles.
- 0.75% methyl paraben free bupivacaine vial (hyperbaric)
- 1% lignocaine 10 mg/ml.
- Lignocaine 4% (heavy)
- A vial of adrenaline 1 mg/ml.

EPIDURAL ANESTHESIA KIT

It is a prepacked sterile disposal kit for epidural anesthesia. It contains:

- Long Tuohy needle
- Epidural catheter with stylet
- Catheter or syringe adaptor
- 0.2 μm pore size bacterial filter
- Preservative-free local anesthetic solution
- Standard syringes and needles
- Lignocaine vial
- Saline
- Sterile dressing, draping material, etc.

CARDIAC ARREST AND CARDIOPULMONARY RESUSCITATION

Cardiac arrest can be defined as the abrupt cessation of effective mechanical activity of the heart and cessation of effective ventilation with consequent unconsciousness.

Causes of Cardiac Arrest

- Major injury, massive hemorrhage.
- Acute hypovolemia, profound shock.
- Hypoxia, hypercarbia.
- Fluid/electrolyte/acid-base imbalance.
- Ventricular tachyarrhythmia.
- Bradycardia, conduction defect.
- Drug toxicity.
- Overdose of anesthesia, sedatives, analgesics.
- Acute vagal reflex activity.
- Pulmonary embolism.
- Tension pneumothorax.
- Pericardial tamponade.
- Electrocution, direct myocardial contact with electrocautery.

- Hypersensitivity reactions.
- Recent myocardial infarction.

Note: There may not be any obvious cause of cardiac arrest in certain cases.

Types

- Complete absence of electrical activity of the heart (cardiac asystole)
- Ventricular tachyarrhythmia : Ventricular fibrillation.
- Lack of cardiac mechanical activity in response to electrical stimulation (electromechanical dissociation).

Manifestations

- No pulse in big peripheral arteries like femoral, brachial, carotid artery.
- Blood pressure: Low, cannot be recorded, MAP may be less than 20 mm Hg.
- Silent precordium, no heart sounds.
- Patient is unconscious, widely dilated pupils, do not respond to light.
- No respiration.
- On ECG
 - Cardiac asystole.
 - Ventricular fibrillation.
 - Electromechanical dissociation (Rhythm may appear normal).
- Absence of pulse oximeter waveform.

Management

The aim is the rapid initiation and continuation of support of ventilation and circulation followed by rapid definitive drug therapy and defibrillation. The causative factor, if any needs correction.

Basic Cardiopulmonary Resuscitation (CPR)
(Basic Life Support)

Airway: Keep the airway open and maintain the patent airway. The head tilt chin lift technique is mostly effective. Chin lift is done by tilting the head backward by applying pressure to forehead while the fingers of other hand placed under the chin supporting the mandible.

Breathing: Mouth-to-mouth ventilation/expired air ventilation. The nares is occluded and the operator expires directly into the mouth of the patient, chest movements are observed to check the adequate expansion of the lungs. It should be done about 12 times per minute.

Circulation: Closed chest (external) cardiac massage/chest compression. The compression of chest is 1½ to 2 inches with fingers of one hand locked on the top of other hand keeping the elbow straight. The shoulders should be directly over the sternum. The rate is 80 to 100/minute; compression: ventilation ratio is 5:1. For one person CPR the ratio, is 15:2. Three to five seconds should be needed for 2 ventilations with a pause between ventilations. Observe for a pulse every 2 to 3 minutes.

CPR should not be stopped for more than 5 seconds except at the time of intubation or defibrillation.

Advanced Cardiac Life Support (ACLS)

- Patient should be laid flat on a hard table, legs should be elevated. Endotracheal intubation.
- Oxygenation with 100% oxygen.
- Positive pressure ventilation. Avoid hyperventilation during CPR as it can impair the ability of chest compressions to generate blood flow.
- ECG monitoring.

- *Ventricular fibrillation:*
 - Defibrillate, may be upto 3 times in rapid sequence with 200, 300, 360 joules. Check the pulse after each time.
 - Adrenaline IV 1 mg and defibrillate with 360 joules.
 - Lignocaine IV 1 to 1.5 mg/kg defibrillate with 360 joules.
 - Treat acid-base imbalance according to blood gas analysis.

Note: The time passed from the cardiac arrest to the first shock is the prime factor for survival.
- *Cardiac asystole:*
 - Adrenaline IV 1 mg
 - Atropine IV 1 mg
 - Isoprenaline infusion 1 to 3 mcg/min.
 - Pacing
- *Electromechanical dissociation:*
 - Adrenaline
 - Calcium chloride
 - Atropine in presence of bradycardia
 - Treat the underlying cause
 - Pericardiocentesis in case of pericardial tamponade
 - Chest tube in cases of tension pneumothorax
- *Other considerations:*
 - IV infusion of fluids.
 - Central venous pressure (CVP) catheterization may be useful.
 - Sodium bicarbonate IV to treat metabolic acidosis.
 - Calcium chloride
 - Blood gas study to continue.
 - Antiarrhythmic drugs (lignocaine, bretylium)
 - Phenylephrine, noradrenaline.
 - Mannitol is helpful to protect the kidneys.
 - Dexamethasone may be given to reduce cerebral edema.

Complications

- Death. Mortality rate is high.
- Fracture of ribs.
- Injury to liver.
- Pneumothorax, hemothorax.
- Brain damage
- Pulmonary edema
- Kidney failure

COMMON DRUGS USED IN CARDIAC ARREST

- *Adrenaline*: 1 mg IV first dose and may be repeated for every 3 to 5 minutes, if needed.
Uses: All cardiac arrests.
- *Atropine sulphate*: 1 mg IV first dose and may be repeated every 3 to 5 min, if needed to total of 3 doses.
Uses : Asystole, bradycardia, heart block.
- *Lignocaine*: 1 to 1.5 mg/kg IV first dose, then 0.5 to 0.75 mg/kg to a total of 3 doses or 3 mg/kg.
Uses: ventricular fibrillation, tachycardia.
- *Magnesium*: 1 to 2 gm over 5 min.
Use: Refractory ventricular fibrillation.
- *Amiodarone*: 300 mg IV first dose, then 150 mg once, if needed.
- *Bretylium tosylate*: 5 mg/kg IV, repeat 10 mg/kg every 5 to 15 min to total 35 mg/kg.
Uses: Cardiac arrest, ventricular fibrillation, tachycardia.
- *Dopamine*: 2 to 5 mcg/kg/min IV infusion titrate to effect.
Use: Hypotension, low cardiac output.
- *Calcium chloride*: 5 to 10 mg/kg IV may be repeated every 5 to 10 min.
Uses: Hypotension, low cardiac output.
- *Noradrenaline*: Initially 0.1 to 0.5 mcg/kg/min IV infusion, titrate to effect.
Use: Hypotension

- *Phenylephrine*: 50 to 200 mcg IV
Use: hypotension.
- *Isoprenaline*: 2 to 20 mcg/min IV infusion titrate to effect.
Use: low cardiac output, atropine refractory bradycardia.
- *Verapamil*: 0.05 to 0.15 mg/kg IV maximum 10 mg, can be repeated in 5 min. as needed.
Uses: Recurrent ventricular tachycardia, atrial fibrillation, flutter.
- *Esmolol*: 0.1 to 0.5 mg/kg IV
Uses: Recurrent ventricular node tachycardia, atrial fibrillation, flutter.
- *Sodium bicarbonate*: 1 mEq/kg IV
Uses: hyperkalemia, metabolic acidosis

POSTRESUSCITATION CARE

- Evaluation to note the adequacy of cerebral, cardiovascular, pulmonary and renal function.
- Continued monitoring in ICU.
- If cause is identified, treat it accordingly.
- Continue prophylactic antiarrhythmic drug therapy. Lignocaine is mostly helpful.
- Mechanical ventilation, whenever needed.
- IV fluid therapy, vasopressors, if required.
- Maintain cerebral oxygen delivery. Avoid hypotension and hypoxia.
- Control cerebral metabolic rate. Prevent hyperpyrexia. Treat seizures, if occurs.
- Prevention and/or treatment of pulmonary edema, cerebral edema. Mannitol therapy. Steroids.
- Monitor urinary output.
- Acid-base therapy according to blood gas analysis.

COMMONLY USED DRUGS IN ANESTHESIA AND ANALGESIA INCLUDING INHALATION AGENTS

Volatile Anesthetic Agents

Halothane

- Potent volatile anesthetic agent, colorless, noninflammable, nonirritant, sweet pleasant smell. Requires thymol for stability.
- Causes bronchodilation.
- Potentiates muscle relaxation.
- Low incidence of nausea/vomiting on recovery.
- Causes vasodilation, hypotension.
- Causes poor analgesia, rapid induction and recovery.
- Increases cerebral blood flow and intracranial pressure (ICP).
- Sensitizes myocardium to catecholamines.
- Myocardial depression, bradycardia, arrhythmia.
- Can cause halothane hepatitis.
- Relaxes uterine muscle.
- About 20% metabolized.
- Postoperative shivering can occur.

Enflurane

- Potent volatile anesthetic agent, noninflammable, nonirritant.
- Causes rapid induction and recovery.
- Potentiates muscle relaxants, poor analgesic.
- Incidence of nausea/vomiting is less.
- Does not sensitize myocardium to catecholamines.
- Causes vasodilation, increases cerebral blood flow and ICP. Causes reflex tachycardia.
- Causes respiratory depression, myocardial depression.
- Epileptogenic.

- About 2% is metabolized.
- Not nephrotoxic.
- Relaxes uterine muscle.

Isoflurane

- Potent volatile anesthetic agent, no reaction with light, metal and soda lime, stable, noninflammable, pungent smell, irritant.
- Causes rapid induction and recovery.
- Potentiates muscle relaxants.
- Does not sensitize myocardium to catecholamines.
- Causes respiratory depression, myocardial depression and reduction of arterial pressure.
- Usually does not increase cerebral blood flow and ICP.
- Only about 0.2% metabolized.

Nitrous Oxide

- It is odorless gas, nonexplosive, nonirritant.
- It causes rapid pleasant induction and recovery.
- It is a good analgesic, but produces weak anesthesia while used alone with only oxygen.
- Nitrous oxide is used usually with other agents.
- It causes no secretions, no bronchospasm.
- Causes direct myocardial depression. Systemic arterial pressure is maintained.
- Muscle tone remains normal.
- Smooth muscle including uterine muscle—no effect.
- Liver and kidney functions unchanged.
- Diffuses more rapidly than nitrogen.
- Diffusion hypoxia can occur.
- Bone marrow depression following prolonged exposure.
- Minimal/no effect on cerebral blood flow.
- *Entonox*: It is a mixture of 50% nitrous oxide in oxygen. It is commonly used for its analgesic properties in obstetrics and for burn dressings. It can be used in other painful procedures.

Induction Agents

Thiopentone Sodium

- Dose : 3-5 mg/kg of 2.5% solution IV 5% solution should not be used.
- Produces effect within 30 sec. Poor analgesic.
- Causes reduction of cardiac output, transient hypotension.
- Significant depression of central nervous system (CNS) and respiratory center.
- Causes significant reduction of muscle tone.
- Mild degree of bronchoconstriction, laryngospasm can occur. No significant placental transfer.
- *Indications:* Induction of anesthesia, control of convulsion.
- *Contraindications:*
 - Porphyria
 - Airway obstruction
 - Fixed cardiac output states: Mitral stenosis
 - Severe shock
 - Adrenocortical suppression
- *Caution:*
 - Intra-arterial injection
 - Extravascular injection

Ketamine

- *Dose:* 2 mg/kg IV can be repeated. 10 mg/kg IM 50 mcg/kg/min as continuous infusion.
- Slow onset of anesthesia.
- Dissociative anesthesia : Profound analgesia
- Increased salivation.
- Tachycardia and hypertension.
- Can cause arrhythmia.
- Respiration is not depressed.
- Causes increase in muscle tone and elevated IOP and ICP.
- *Indications:* Sole anesthetic agent, induction agent, total IV anesthesia.

- *Contraindications:*
 - Hypertension
 - History of cerebrovascular accident
 - Raised IOP
 - Recent penetrating eye injury
 - Psychiatric patient.
- *Complications:*
 - Emergence delirium, excitement
 - Hallucinations
 - Anxiety, disorientation, dysphoria
- Hepatic metabolism

Etomidate

- Dose: 0.2 to 0.3 mg/kg IV. About 12 times more potent than thiopentone.
- Potent induction agent. Consciousness lost within 60 sec.
- Maintains cardiac output and blood pressure.
- Recovery rapid, smooth, occurs within 6 to 8 min.
- High incidence of nausea and vomiting.
- Ideal for day case surgery.
- Causes reduction in circulating corticosteroids.

Propofol

- Dose : 2 to 2.5 mg/kg IV produces anesthesia in about 30 sec. Maintenance of anesthesia with continuous infusion 0.1 to 0.2 mg/kg often combined with an opioid.
- Provides no analgesia. Potent amnesic. Can cause apnea and loss of gag reflex.
- Can cause mild hypotension.
- No accumulation. Rapid and complete recovery.
- Contraindicated in known epileptics and in patients with history of allergy/hypersensitivity.

Intravenous Sedatives/Analgesics

Diazepam

- Dose: 0.3 to 0.5 mg/kg IV. Onset of sleep slow and recovery prolonged.
- Causes mild muscle relaxation.
- Terminates seizure activity
- Sedative, anxiolytic.
- Minimal cardiorespiratory depression
- Hepatic elimination.

Lorazepam

- Dose 1 to 4 mg. Longer onset and duration of action.
- Effective tranquilizer, sedative, anxiolytic and amnesic.
- Can cause low blood pressure.
- Less incidence of thrombophlebitis.
- Hepatic elimination.

Midazolam

- Dose: 0.15 to 0.5 mg/kg. Onset of sleep slow, Potent amnesic effect. Recovery is usually within 6 to 8 min.
- Produces hypnosis, anxiolysis and muscle relaxation.
- Anticonvulsive activity.
- Can cause low blood pressure.
- No hang over effect. No venous sequelae.
- Can be used in continuous infusion (0.125 to 0.25 mcg/kg/min)

Fentanyl

- A synthetic opioid, more potent than morphine.
Dose: 50 to 100 mcg. Onset is rapid within 2 min.
- Duration is short, about 30 min.
- Causes profound respiratory depression. Little effect on cardiovascular system. Less histamine release.
- Can be used in continuous infusion.
- Can cause wooden chest effect.
- Hepatic elimination.

Morphine

- Dose: 2 to 10 mg
- Analgesic, sedative, hypnotic.
- Can cause low blood pressure and cardiac output, respiratory depression and even apnea, depression of CNS.
- Tolerance and withdrawal effect after long-term use.
- May be given as IV infusion or by patient controlled analgesia technique or to facilitate prolonged mechanical ventilation.
- Hepatic elimination.
- Causes nausea, vomiting, constipation, addiction.
- Can cause hyperglycemia.
- Passes through placental barrier.

Pethidine

- Synthetic, morphine like analgesic, sedative, hypnotic and anxiolytic. Dose: 1 to 2 mg/kg.
- Depresses respiration, raises CSF pressure.
- Atropine like effect: Dry mouth.
- Can cause addiction.
- Causes less release histamine.
- Passes through placental barrier.
- Causes reduction in muscle tone.
- Side effect: Cardiovascular collapse, nausea/vomiting, vertigo, tremor.

Pentazocine

- Synthetic narcotic analgesic. Dose: 20 to 60 mg.
- Sedative
- Mild respiratory depression.
- Nausea, vomiting, constipation: Less
- Mild narcotic antagonist.
- May cause dysphoria.

Muscle Relaxants

Pancuronium

- Bisquarternary aminosteroid, free from hormonal activities.
- Nondepolarizing muscle relaxant. Dose : 0.1 mg/kg.
- Acts within 2 to 3 min and lasts for about 30 min.
- Does not cross the placenta and blood-brain barrier.
- Mild sympathomimetic and vagal blocking effect.
- Blood pressure is well maintained and may even be increased .
- No cumulative effect.
- Eliminated by kidneys and liver.

Vecuronium

- Potent nondepolarizing muscle relaxant. Dose : 0.1 mg/kg. Onset of action at about 2 min and duration of action is about 15 min.
- No histamine release; Neither ganglion blocking nor vagal blocking effect. Devoid of sympathomimetic effect.
- Pulse rate and blood pressure are not much altered.
- Metabolism is mostly dependent of liver. It is better avoided in severe liver disease.
- It may show spontaneous recovery. But antagonism of the block can be achieved by neostigmine.

Atracurium

- Short-acting nondepolarizing muscle relaxant. Dose is 0.6 mg/kg IV slow onset of action, duration of action is about 20 minutes.
- Can cause high heart rate and low blood pressure.
- Can release histamine.
- Devoid of sympathetic stimulation, vagolytic and ganglion blocking effects.
- Ester hydrolysis is the main metabolic pathway. It also provides Hoffman's degradation.
- Relaxant of choice in patients with severe liver and kidney disease.

Mivacurium

- Synthetic nondepolarizing muscle relaxant with short duration of action 10 to 20 min.
Dose: 0.15 to 0.25 mg/kg IV produces block in about 3 min.
- Can be used as continuous infusion in a dose of 5 to 6 mcg/kg/min.
- It is hydrolyzed by plasma cholinesterase. Hepatic degradation and renal and biliary excretion are mostly insignificant.
- Histamine release insignificant.
- Cardiovascular effects are minimal.

Pipecuronium

- Long acting nondepolarizing muscle relaxant.
Dose: 0.07 to 0.085 mg/kg IV. Muscle relaxation is within 2.5 to 3 min. Duration of effect ranges from 45 to 60 min.
- No ganglion blocking effect, no vagolytic effect, does not release histamine.
- Minimum cardiovascular effects.
- No cumulative effect.
- Effect is well-reversed by neostigmine.
- About 10% of the drug undergoes hepatic degradation, 20% excreted unchanged through biliary route and about 70% through kidneys.

Cisatracurium

- Short acting nondepolarizing muscle relaxant.
Dose: 0.2 to 0.5 mg/kg IV slow onset of action.
- It can be used as continuous infusion for prolonged effect.
- Effect is potentiated by hypokalemia.
- It is mostly similar to atracurium in effects.
- Elimination by Hoffman's degradation and ester hydrolysis.
- Can be used for patients with renal and hepatic disease.

Succinylcholine (Suxamethonium)

- Synthetic depolarizing muscle relaxant. Ultrashort acting. *Dose:* 1 mg/kg IV *Duration of effect* 3 to 4 min.
- Causes characteristic generalized muscular fasciculations before causing paralysis. Causes postoperative muscle pains.
- Causes increased salivation and gastric secretion.
- Mild bradycardia, mild rise of blood pressure and arrhythmia can occur.
- Does not cross the placental barrier.
- Causes mild histamine release.
- Increases serum potassium and may increase intraocular pressure (IOP), intracranial pressure (ICP) and intragastric pressure.
- May trigger malignant hyperpyrexia.
- Pretreatment with nondepolarizing muscle relaxants may attenuate muscle pains.
- Prior administration of diazepam can prevent fasciculations, increased creatine phosphokinase (CPK) level and postoperative myalgia.
- It is destroyed in the body by plasma pseudo-cholinesterase.
- *Contraindications:*
 - Patients suffering from burns, muscle injury, upper and lower motor neurone disease, muscle disease.
 - Avoid in patients with arrhythmias, tetanus and penetrating eye injury.

Local Anesthetic Agents***Lignocaine***

- An amide local anesthetic. Total dose ranges from 500 to 750 mg. Usually for infiltration 2%, for nerve blocks 1 to 1.5%, for spinal block 5% (heavy) and for epidural block 1.5 to 2% lignocaine is used.

- Adrenaline 1 in 250000 may be added to provide prolonged effect.
- Lignocaine jelly 1 to 2% is used for urethral analgesia.
- Lignocaine has little effect on blood vessels.
- Metabolized by liver and excreted through the kidneys.
- Also used as antiarrhythmic drug to treat ventricular arrhythmias.
- Maximum safe dose of lignocaine (plain) is 4 mg/kg and with adrenaline 8 mg/kg.

Prilocaine

- A safe local anesthetic. The recommended maximum dose is 7mg/kg
- Clinically, it is very similar to lignocaine. But the addition of vasoconstrictor, adrenaline is not needed.
- Its metabolite, orthotoluidine can cause methemoglobinemia and hypoxia following use of prilocaine in large doses, more than 500-600 mg. However, this can be reversed by methylene blue 1 mg/kg IV.

Bupivacaine

- Amide group of local anesthetic, more potent than lignocaine. Duration of action may range from 3 to 12 hours.
- Maximum safe dose of bupivacaine (plain) is 2 mg/kg and with adrenaline 2.5 g/kg.
- It has slower onset of action than lignocaine.
- Low placental barrier, suitable for use in obstetrics.
- Available in 0.25 to 0.75% solution.
- Not recommended for IV regional anesthesia.
- Metabolized in liver with little excretion through the kidneys.

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Index

A

-
- Acute burns in children 60
 - Acute intestinal obstruction
 - 115
 - acute pancreatitis 123
 - treatment 124
 - anesthesia 117
 - maintenance of anesthesia 117
 - monitoring of vital signs 117
 - premedication 117
 - bleeding esophageal varices 118
 - anesthesia 119
 - postoperative care 120
 - postoperative complications 120
 - preanesthetic evaluation 119
 - preanesthetic preparation 119
 - problems 118
 - surgical management 118
 - causes 115
 - injury of diaphragm 124
 - management 125
 - manifestations 125
 - laboratory findings 116
 - postoperative care 118
 - preoperative assessment 116
 - preoperative preparation 116
 - problems 116
 - ruptured/dissecting abdominal aortic aneurysm 120
 - anesthesia 122
 - investigations 121
 - postoperative care 122
 - preoperative evaluation 120
 - preoperative preparation 121
 - Addison's disease 189
 - anesthetic care 190
 - management 190
 - manifestations 190
 - steroid cover during perioperative period 190
 - types 189
 - primary 189
 - secondary 189
 - Airway burn 145
 - complications 147
 - management 146
 - manifestations 146
 - prevention 146
 - Airway rupture 147
 - complications 148
 - management 147
 - manifestations 147
 - Anesthesia for labor and delivery in mild/severe pre-eclampsia 95
 - abruptio placenta 103
 - anesthetic implication 104
 - clinical manifestations 103
 - management 103
 - acute inversion of uterus 107
 - causes 107

- management 107
- manifestations 107
- anesthetic implications 100
- antepartum hemorrhage 101
 - management 102
- ectopic pregnancy 100
 - management 101
- hemorrhage in early pregnancy 99
 - management 100
- management of general anesthesia 98
- postpartum hemorrhage 105
 - management 105
- regional anesthesia 95
 - advantages 96
 - disadvantages 96
- retained placenta 105
 - anesthetic implications 106
 - management 106
- toxemia pregnancy 96
- uterine rupture 104
 - management 104
- Anesthesia for neurosurgery 131
 - induction of anesthesia 131
 - maintenance of anesthesia 132
 - postoperative care 132
 - preoperative assessment 131
- Anesthesia for obstetric emergency 87
 - anesthesia for cesarean section 91
 - failed intubation drill 95
 - general anesthesia 92
 - indications 91
 - preanesthetic check-up 92
 - regional anesthesia 93
- pain during labor and delivery 90
 - pain relief for labor and delivery 90
- physiological changes in pregnancy 88
 - acid-base changes 89
 - cardiovascular system 88
 - endocrine system 89
 - gastrointestinal system 89
 - metabolism 90
 - renal system 89
 - respiratory system 88
- Anesthesia for spinal cord compression 137
 - hypophysectomy 139
- Anesthesia for surgical emergencies in neonates, infants and children 63
 - anesthesia in specific conditions 71
 - acute abdomen 83
 - bronchoscopy 79
 - choanal atresia 78
 - congenital diaphragmatic hernia 71
 - congenital lobar emphysema 80
 - congenital pyloric stenosis 75
 - encephalocele 81

esophagoscopy 80
 intestinal obstruction 76
 myelomeningocele 81
 necrotizing enterocolitis 77
 omphalocele and
 gastroschisis 74
 tracheoesophageal fistula
 and esophageal atresia 72
 anesthesia induction techniques 68
 common IV inducing agents 69
 muscle relaxants in
 common use 69
 anesthetic care for some
 specific nonsurgical cases 84
 respiratory distress syndrome 84
 tetanus neonatorum 84
 equipment for pediatric
 anesthesia 67
 anesthesia machine 68
 breathing system 68
 monitoring 68
 fluid therapy 69
 neonatal physiology 64
 airway 64
 blood 65
 cardiovascular system 64
 central and autonomic
 nervous system 65
 fluid balance 66
 hepatorenal system 65
 metabolism and thermoregulation 65
 respiratory system 64

B

Blunt cardiac injury 158
 diagnosis 158
 management 158
 Bronchial asthma 184
 general anesthesia 185
 preoperative assessment 184
 regional anesthesia 185
 Burns 53

C

Cardiac arrest 203
 causes 203
 common drugs 207
 adrenaline 207
 amiodarone 207
 atropine sulphate 207
 bretylium tosylate 207
 calcium chloride 207
 dopamine 207
 esmolol 208
 isoprenaline 208
 lignocaine 207
 magnesium 207
 noradrenaline 207
 phenylephrine 208
 sodium bicarbonate 208
 verapamil 208
 complications 207
 management 204
 manifestations 204
 postresuscitation care 208
 types 204
 Cardiac laceration 160
 associated factors 160
 clinical manifestations 160

- complications 160
 - management 160
- Cardiopulmonary resuscitation 203
- Cardiothoracic surgery 141
 - preanesthetic assessment 142
 - anesthesia for thoracotomy 143
 - investigations 142
 - physical examination 142
 - postanesthetic care 144
 - premedication 143
 - preparation for surgery 143
 - removal of inhaled foreign body 144
 - anesthesia 145
 - management 145
- Chemical burns 59
- Chest injury 46
 - blunt injury 46
 - diaphragmatic rupture 49
 - flail chest 48
 - management 48
 - manifestations 48
 - hemathorax 48
 - injury to heart and great vessels 49
 - pneumothorax 47
- Common neurosurgical emergencies 133
 - anesthesia for patients with head injury 135
 - anesthesia 136
 - preanesthetic assessment 136
 - management of patients with head injuries 133
- Commonly used drugs in anesthesia and analgesia including inhalation agents 209
 - induction agents 211
 - etomidate 212
 - ketamine 211
 - propofol 212
 - thiopentone sodium 211
 - intravenous sedatives/analgesics 213
 - diazepam 213
 - fentanyl 213
 - lorazepam 213
 - midazolam 213
 - morphine 214
 - pentazocine 214
 - pethidine 214
 - local anesthetic agents 217
 - bupivacaine 218
 - lignocaine 217
 - prilocaine 218
 - muscle relaxants 215
 - atracurium 215
 - cisatracurium 216
 - mivacurium 216
 - pancuronium 215
 - pipecuronium 216
 - succinylcholine 217
 - vecuronium 215
 - volatile anesthetic agents 209
 - enflurane 209
 - halothane 209
 - isoflurane 210
 - nitrous oxide 210
- Congestive heart failure 178
 - anesthetic implications 178
 - clinical manifestations 178

- diastolic dysfunction 178
- left ventricular failure 178
- systolic dysfunction 178
- treatment 178
- Considerations for cardiac surgery 155
- preoperative assessment 155
 - heart block 157
 - investigations 156
 - management of heart failure 157
 - myocardial infarction 157
 - preoperative drug therapy 155
 - preoperative preparation 156
- Cushing's syndrome 189
- Cut-throat injury 173

D

- Dehydration 24
 - biochemical manifestations 24
 - causes 24
 - clinical manifestation 24
 - treatment 24
- Diabetes mellitus 191
 - anesthetic management 192
 - types 191
- Diabetic ketoacidosis 193
 - clinical manifestations 193
 - emergency anesthesia 194
 - management 193
 - preanesthetic preparation 193

E

- Electrical burns 60
- Emergency anesthesia 1
 - investigations 4
 - physical examination 3
 - preanesthetic assessment 2
 - preanesthetic medication 7
 - anesthetic management 7
 - preanesthetic preparation 7
 - special considerations 4
 - full stomach 6
 - volemic status 4
- Emergency anesthesia and liver disease 194
 - anesthetic implications 195
 - bleeding problems 195
 - hepatorenal syndrome 195
- Emergency anesthesia and renal disease 196
 - anesthetic implications 197
 - common investigations 196
 - cardiovascular disturbances 197
 - fluid balance 196
 - neurological disturbances 197
- Emergency anesthesia for acute abdominal conditions 110
 - various methods of anesthesia 110
 - general anesthesia 111
 - preanesthetic preparation 113
 - regional anesthesia 111

Emergency ENT anesthesia 166
 acute epiglottitis 169
 management 169
 manifestations 169
 epistaxis 168
 anesthesia 168
 management 168
 pharyngeal abscess 168
 management 168
 manifestations 168
 postoperative bleeding tonsil 166
 management 167
 manifestations 166
 Emergency neurosurgery 127
 intracranial pressure 128
 effect of drugs and techniques 130
 effects of raised ICP 128
 methods of lowering ICP 129
 methods of preventing rise of ICP during anesthesia 129
 Emergency operation theater 200
 Epidural anesthesia kit 203
 Eye surgery 162
 intraocular pressure 162
 factors increasing IOP 163
 factors lowering IOP 162
 factors regulating IOP 162

F

Facial trauma/injury 45
 Fiberoptic bronchoscopy 149
 anesthesia 150

 complications 150
 contraindications 150
 indications 149
 postoperative care 150
 Foreign bodies in esophagus 170
 larynx/tracheobronchial tree 171
 investigations 172
 management 172

H

Head trauma/injury 42
 effect of trauma to brain 42
 cerebral edema 42
 extradural hematoma 42
 fracture of skull 42
 general anesthesia 43
 initial management 43
 Heart block 182
 Hypercalcemia 30
 causes 30
 management 31
 manifestations 30
 Hyperkalemia 24
 anesthetic considerations 26
 causes 25
 clinical manifestations 25
 treatment 25
 Hyponatremia 27
 treatment 28
 Hypertension 176
 causes 176
 management of anesthesia 176
 induction of anesthesia 177
 maintenance of anesthesia 177

postoperative care 177
preoperative assessment 176
types 176
Hypocalcemia 31
 anesthetic considerations 32
 causes 31
 management 32
 manifestations 31
Hypokalemia 26
 anesthetic considerations 27
 causes 26
 clinical manifestations 27
 treatment 27
Hyponatremia 28
 causes 28
 associated with hypervolemia 28
 associated with hypovolemia 28
 associated with normovolemia 29
 management 29
 manifestations 29
Hypothyroidism 188

I

Injury caused by cardiac catheterization 159
Injury of bones 50
 intra-abdominal injury 51
 anesthetic management 52
Intraoperative bronchospasm 186
 causes 186
 management 186

Ischemic heart disease 180
 anesthesia 181
 manifestations 181

L

Local anesthesia for neurosurgery 139
 advantages 140
 contraindications 140
 disadvantages 140
 indications 139

M

Massive hemothorax 153
 management 153
 manifestations 153
Mendelson's syndrome 94
Metabolic acidosis 32
 biochemical effects 33
 causes 32
 clinical effects 33
 management 33
Metabolic alkalosis 33
 biochemical manifestations 34
 causes 33
 clinical manifestation 34
 management 34
Mitral stenosis 179
 treatment 179
 anesthesia 179
 induction and maintenance of anesthesia 180
 postoperative care 180
 preoperative assessment and preparation 180

N

Neck trauma/injury 45

O

Oculocardiac reflex 163
 ocular emergency requiring
 immediate treatment 164
 ruptured globe 164
 threatened perforation of
 corneal ulcer 165
 penetrating eye injury 165
 management 165
 problems 165
 prevention 163
 surgical requirement during
 intraocular surgery 164
 Open pneumothorax 152
 management 153

P

Penetrating injury of heart 159
 Perforated bowel and peri-
 tonitis 113
 acute abdomen 114
 anesthesia 114
 postoperative care 114
 preoperative assessment
 113
 preparation 114
 problems 113
 Pericardial tamponade 154
 manifestations 154
 treatment 154

Pneumothorax 150
 classification 151
 manifestations 151
 open 151
 simple 151
 tension pneumothorax
 151
 treatment 152
 Pulmonary fat embolism 49
 management 50
 manifestations 49

R

Radiation injury 60
 Regional anesthesia 10
 anaphylactic shock 20
 clinical features 20
 management 21
 bacteremic (septic) shock 19
 clinical stages 19
 diagnosis 19
 treatment 20
 cardiogenic shock 18
 diagnosis 18
 pathophysiology 18
 treatment 18
 causes 12
 assessment 13
 circulation failure 12
 pathophysiology 13
 classification 12
 hypovolemic shock 13
 metabolic effects 15
 treatment 15
 manifestations 12
 Respiratory acidosis 34
 biochemical manifestation
 34

- causes 34
- clinical manifestation 34
- management 35
- Respiratory alkalosis 35
 - biochemical manifestation 35
 - causes 35
 - clinical manifestation 35
 - management 36

S

- Spinal kit 202

T

- Thermal burns 54
 - anesthetic considerations 58
 - maintenance of anesthesia 58
 - monitoring 59
 - extent of burn injury 54
 - pathophysiology 55
 - resuscitative measures 57
 - smoke inhalation 56
 - management 56
 - manifestations 56

- Thyrototoxic crisis 187
 - manifestations 187
 - treatment 187
- Thyrotoxicosis 186
- Tracheostomy 148, 169
 - advantages 148
 - anesthesia 148, 170
 - complications 149, 170
 - indications 148, 169
 - side effects 149, 170
- Trauma 37
 - anesthetic management 40
 - induction of anesthesia 40
 - maintenance of anesthesia 40
 - monitoring 41
 - postoperative care 41
 - recovery 41
 - role of regional anesthesia 41
 - assessment 38
 - laboratory investigations 39
 - types 38
 - blast injury 38
 - blunt trauma 38
 - crush injury 38
 - cut injury 38
 - penetrating trauma 38